9-6920-357-10-2

TM 9-6920-357-10-2

TECHNICAL MANUAL

OPERATOR'S MANUAL
TRAINER, LASER GUNNERY: M55 W/E
(6920-00-689-4036)
AND
TRAINER, FIELD ARTILLERY:
DIRECT FIRE (W/O LASER)
(6920-01-026-0136)

HEADQUARTERS, DEPARTMENT OF THE ARMY
JANUARY 1979

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WARNING

The laser beam is safe when the trainer is operated in the FLASH MODE.

Precautions are required to prevent possible eye damage when the trainer is operated in the CONTINUOUS MODE. Staring into the laser output or staring at the laser light reflection from a mirror-like surface can be hazardous out to a range of 4 kilometers.

Observe the following precautions when the trainer is operated in the CONTINUOUS MODE.

Do not look into the laser beam or at mirror-like reflections of the laser beam. Staring into the laser beam may cause permanent eye damage, and is specifically prohibited.

Do not fire trainer at personnel.

Do not fire trainer at mirror-like surfaces.

The trainer is to be operated in the CONTINUOUS MODE only when the target or other opaque backstop exists to terminate the beam.

TB-MED-279 is the source document for laser safety.

Operation of this trainer involves the use of internal high voltages of 1,200 to 10,000 volts that can cause death.

Back of trainer will not be opened during operation except by authorized maintenance personnel.

WARNING

Exposed high voltage is limited to the female high voltage connector on the high voltage power supply module and the corresponding male connector on the plasma tube. However, circuit failures can cause dangerous potentials to be present elsewhere. If failure is noted, notify authorized maintenance personnel immediately.

Make sure the trainer LASER SAFE FIRE circuit breaker is set to SAFE and the BORESIGHT OFF FIRING switch is in the OFF position before connecting power source.

Do not walk in front of laser after power source is connected.

Observe all range safety regulations during operation.

WARNING
DANGEROUS CHEMICALS
FINAL INSPECTION

Dry cleaning solvent or mineral spirits paint thinner is flammable and should not be used near an open flame. Fire extinguishers should be provided. Use flammable material only in well-ventilated places.

Trichloroethane is toxic. Avoid breathing its fumes or exposure to skin.

Technical Manual
No. 9-6920-357-10-2

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC 30 January 1979

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Reporting Errors and Recommending Improvements. You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publication and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Armament Materiel Readiness Command, ATTN: DRSAR-MAS, Rock Island, IL 61299. A reply will be furnished to you.

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CHAPTER 1
INTRODUCTION

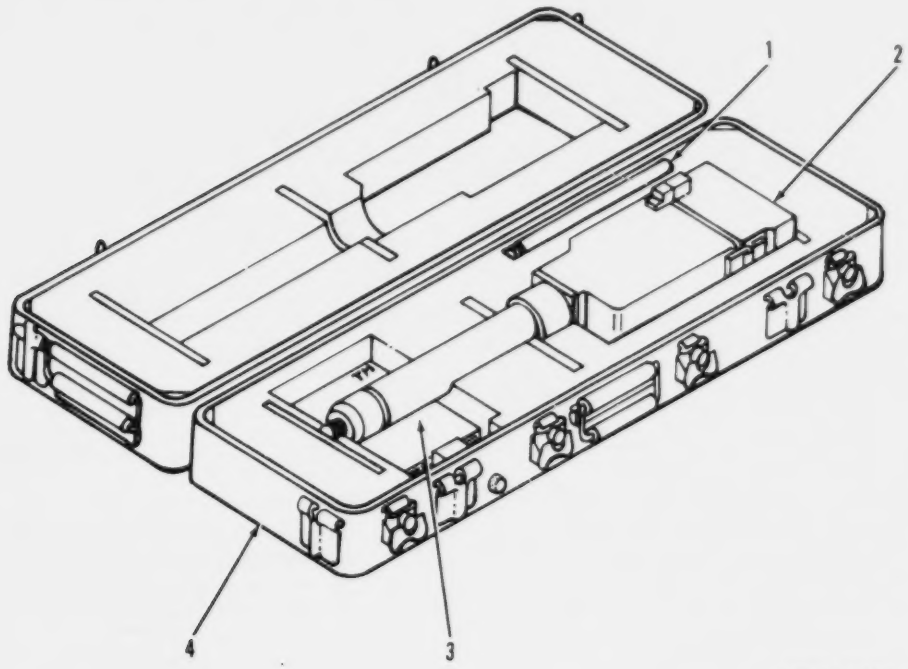
Section I. GENERAL

1-1. **Scope.** This manual is for your use in operating and maintaining the Laser Gunnery Trainer M55 w/ Equipment (fig 1-1) hereafter referred to as laser, and the Field Artillery Direct Fire Trainer (w/o Laser) (fig 1-2), referred to as ADFT. Use of laser on tanks is not covered in this manual.

1-2. **Maintenance Forms and Records.** Maintenance forms and records that you are required to use are listed and explained in TM 38-750.

1-3. **Reporting Equipment Improvement Recommendations (EIR).** EIR's will be prepared on SF 368, Quality Deficiency Report (QDR). Instructions for preparing EIR's are provided in TM 38-750, The Army Maintenance Management System. EIR's should be mailed directly to Commander, US Army Armament Materiel Readiness Command, Attn: DRSAR-MAO, Rock Island, IL 61299. A reply will be furnished directly to you.

1-4. **Application of Boresighting Procedures.** Boresighting procedures outlined in this TM are not acceptable as a method of boresighting and will not be used when boresighting weapon for live firing. However, when conducting training with the ADFT, these procedures may be used.



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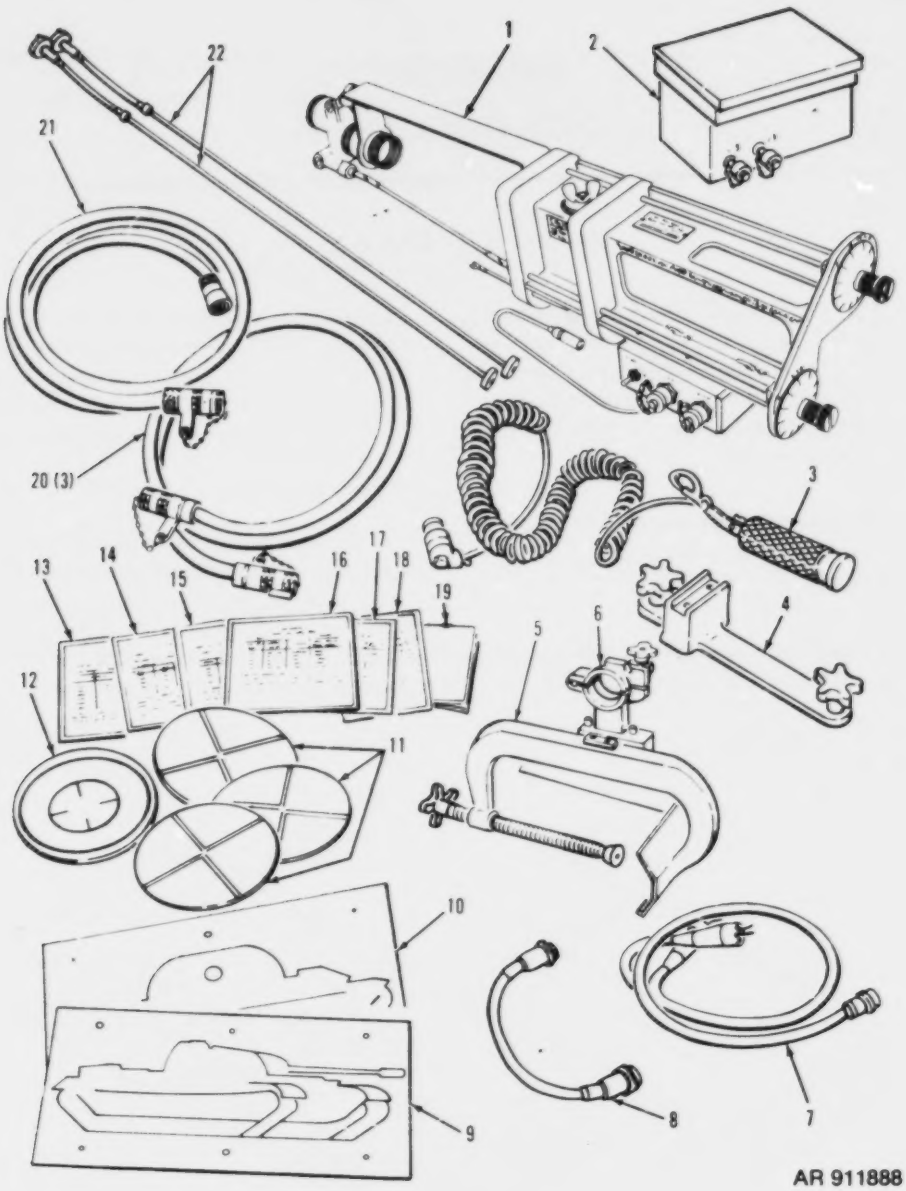
Legend for fig 1-1.
1. Barrel extension - 11741689 (not required for artillery application)
2. Laser gunnery trainer M55 - 11741700
3. TM 9-6920-357-10-1
4. Carrying case - 11743778

Figure 1-1. Laser gunnery trainer M55 with equipment



Legend for fig 1-2.

1. Deflector optical assembly - 11746410
2. Distribution box - 11746450
3. Lanyard switch - 11746480
4. Adapter assembly for M114A1/M114A2 howitzer - 11747146
5. Mount assembly - 11747147
6. Mount - 11746495
7. Cable assembly (10 ft) - 11746454
8. Adapter cable assembly - 11747152
9. Target assembly, moving - 11746475
10. Target assembly, stationary - 11746468
11. Boresight target assembly (3) - 11746461
12. Laser target assembly - 11746464
13. Deflection table for M101A1 howitzer - 11747153
14. Deflection table for M102 howitzer - 11747154
15. Deflection table for M114A1/M114A2 howitzer - 11747155
16. Deflection table for M109A1 howitzer - 11747156
17. Deflection table for M109 howitzer - 11747164
18. Deflection table for M198 howitzer - 11748078
19. Operator's manual - TM 9-6920-357-10-2
20. Cable assembly (20 ft) (3) - 11746452
21. M109 power cable assembly - 11747170
22. Control rods (2) - 11746446

Figure 1-2. Field artillery direct fire trainer w/o laser

Section II. DESCRIPTION AND TABULATED DATA

1-5. **Description.**

a. *Laser and ADFT.* The laser and ADFT are used to train gunner personnel in fire-adjustment and tracking operations while engaging both stationary and moving targets on a one-to-ten (1:10) scale range (e.g., 40 to 160 meters represents 400 to 1600 meters) and target speed (e.g., 0 to 2.5 mph represents 0 to 25 mph). The laser and ADFT will simulate firing exercises without having to move the howitzer to a live firing range and without expending either sub-caliber or service ammunition. The laser and ADFT are used with the following weapons:

(1) 105-mm Howitzer M101A1
(2) 105-mm Howitzer M102
(3) 155-mm Howitzer M109
(4) 155-mm Howitzer M109A1
(5) 155-mm Howitzer M114A1
(6) 155-mm Howitzer M114A2
(7) 155-mm Howitzer M198

b. *Laser.*

(1) The laser consists of a plasma laser tube, a lens assembly, a high voltage power supply, a timing circuit card, an electromagnetic interference (EMI) filter, and associated switches, lights, and connectors. As shown in the block diagram (fig 1-3), trigger input power is provided through external connector 1J1 and goes directly to EMI filter FL1. Operating voltage is 24 ± 6 vdc, which is supplied by the vehicle in which the trainer is mounted or separate power supply. The mounting ring provides the power ground return. Attenuation, necessary to meet the EMI requirements of the ADFT, is provided by EMI filter FL1.

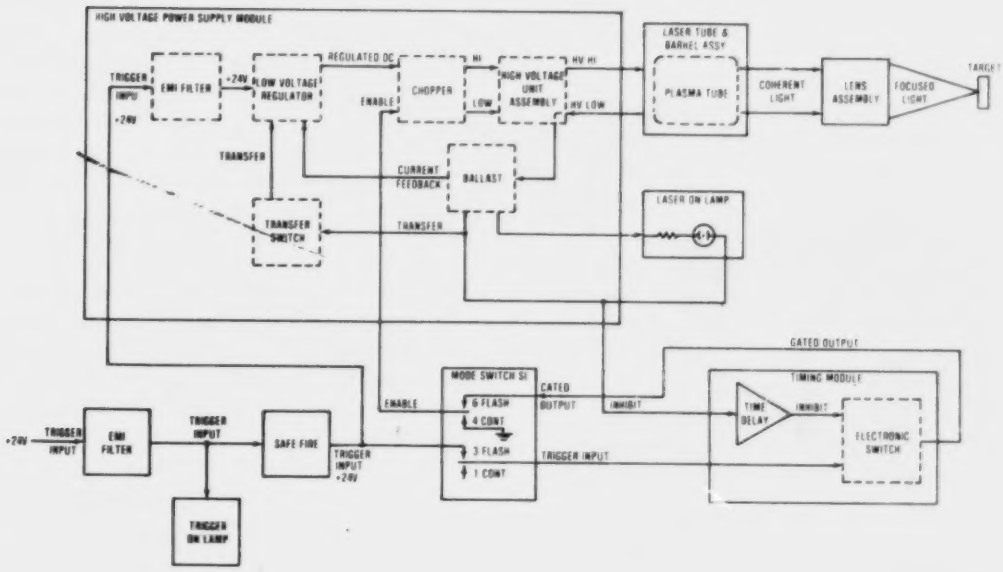


Figure 1-3. Laser gunnery trainer M55 - block diagram

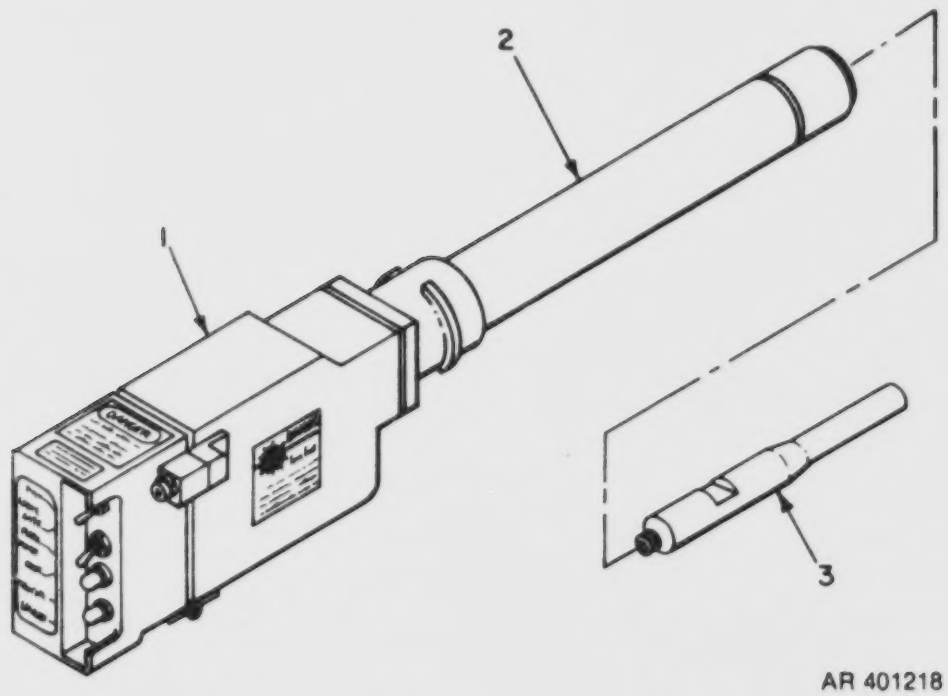
(2) The laser (fig 1-4) is a helium-neon gas type laser. It produces a single, bright shot of intense red light each time the BORESIGHT OFF FIRING switch or LANYARD switch is activated and 24 vdc has been applied. This visible red spot enables the crewman to accurately determine how well he/she is laying his/her gunsights and tracking the target. In addition, a supervising scorer can observe how accurately and proficiently the crewman is operating the howitzer weapon system. The laser optics are fixed focused to obtain a spot approximately 5/8 inch in diameter at a range of 60 meters under various background light levels. The laser (fig 1-4) consists of an electronics assembly (1), a barrel assembly (2), and a barrel extension (3).

NOTE

The barrel extension is not required for artillery application.

(3) The laser may require operation in CONT MODE up to 30 seconds and possibly up to 30 minutes to fire the first shot of laser light following a period of nonuse. In CONT MODE, a warm up shot is required following installation and any subsequent rest periods during the training day. The laser will then fire immediately in either the FLASH or CONT MODE each time 24 vdc is applied and the BORESIGHT OFF FIRING switch or the LANYARD switch is activated.

(4) When the laser is not in use, a carrying case (4, fig 1-1) has been designed for its storage and transportation. This case includes four shock plates, four latches, four shear latches, and a drain cock. In addition, the case has three handles to facilitate handling. The cushioning material inside the case is polyethylene foam. The laser is stored in the carrying case as a complete unit. The barrel extension (1) and technical manual TM 9-6920-357-10-1 (3) are also stored in the carrying case.



Legend for fig 1-4
1. Electronics assembly - 11737724
2. Barrel assembly - 11741701
3. Barrel extension - 11741689 (not used)

Figure 1-4. Laser gunnery trainer M55 without carrying case

(5) The laser has one major identification plate (fig 1-5) located on its left-hand side. The identification plate contains the official nomenclature, serial number, month and year of manufacture, manufacturer code identification, procuring agency code identification, and part number. In addition, two blank spaces are provided for the inclusion of supplemental data.

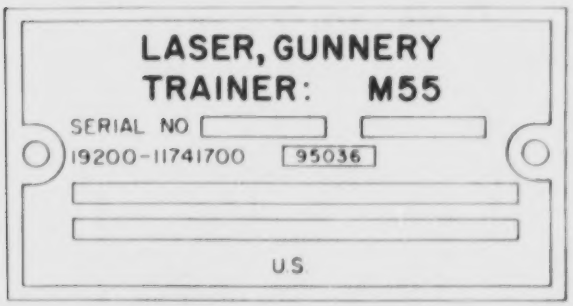


Figure 1-5. Laser identification plate

c. *ADFT.*

(1) *General.* The ADFT is packaged in two containers. One container is a four-man portable carrying case which contains the deflector optical assembly, mount assembly, lanyard switch, cable assemblies, distribution box, adapter assembly, control rods, deflection tables, target assemblies, adapter cable assembly, and manual. A drain cock is on the front of the case to equalize internal pressure. Figure 1-2 shows these items out of the case and figure 1-6 shows them packed in the case. The other case (fig 1-7) is a four-man portable wooden shipping and storage container which contains the target support assembly, two base assemblies, and associated hardware. All targets and the target support assembly are made of an aluminum alloy with a retroreflective coating on the front and rear surfaces, except for the three 8-inch boresight targets which are not retroreflective.

(2) *Equipment packed in carrying case.*

(a) Deflector optical assembly (1, fig 1-2). The deflector optical assembly provides initial beam alignment in addition to elevation and deflection adjustment during boresighting procedures and when implementing inputs from the deflection tables.

(b) Distribution box (2, fig 1-2). The distribution box is a junction box containing connector J2 which connects to 24 vdc power supply. The distribution box also provides the capabilities of connecting four individual power cables.

(c) The plug on the LANYARD switch cable (3, fig 1-2) connects to J5 on the control box assembly (fig 2-10). The snap on the LANYARD switch is attached to the weapon lanyard firing cord forward of the wooden knob. When pulled, the LANYARD switch applies electrical power and fires the laser in FLASH or CONT MODE. The cap of the switch can be loosened to fire the laser during extended warmups. The switch is normally stored in the distribution box.

(d) M114 adapter assembly (4, fig 1-2). This adapter replaces the "c" clamp portion of the mount assembly (5) only when the trainer is mounted on the stuffing box of the M114A1 and M114A2 Howitzers.

(e) Mount assembly (5, fig 1-2). This mount is attached to the recoil mechanism of the M101A1, M102, M109, M109A1, and M198 Howitzers. The "c" clamp hand knob must be on the right side of the recoil mechanism on all installations (when facing into breech of gun).

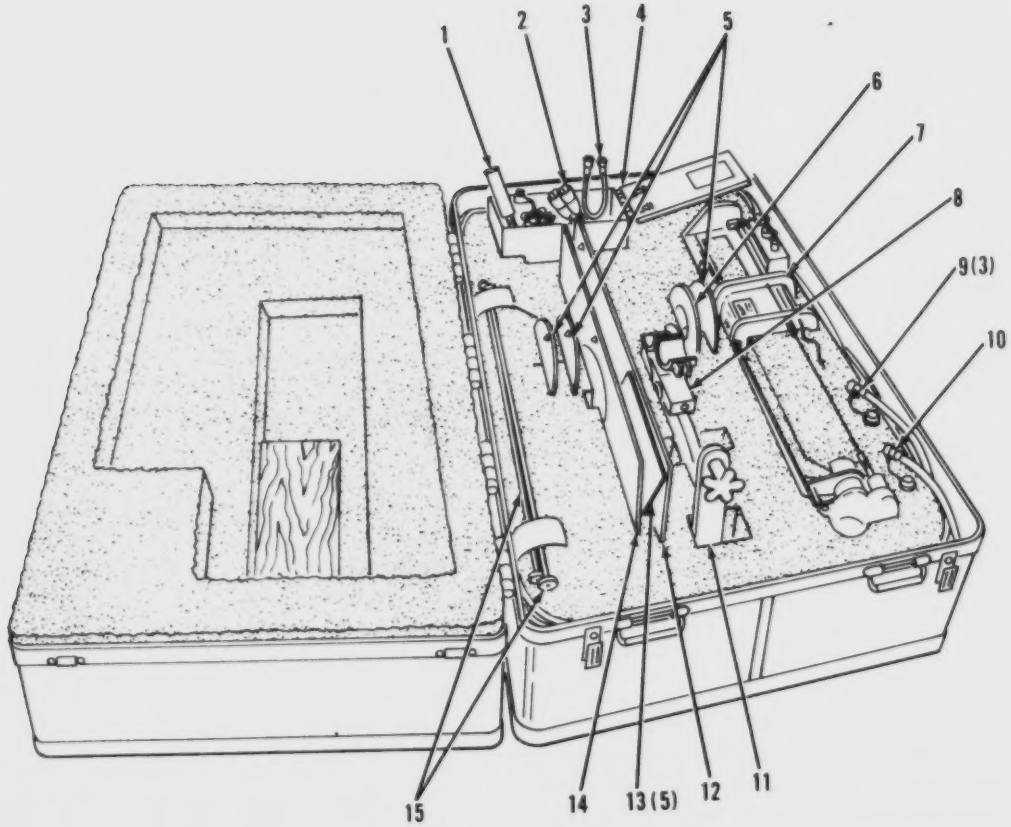
(f) Mount (6, fig 1-2). The mount is used to support the laser on all howitzers and for all applications the hand knob must be on the left side facing into the breech.

(g) Cable assembly (10 ft) (7, fig 1-2). This cable assembly connects the distribution box to the 24 vdc power supply. A fuse has been placed in the 24 volt line of the cable at the positive (+) battery terminal.

(h) Adapter cable assembly (8, fig 1-2). A 12 inch adapter cable assembly is used to make cables of different lengths when up to four trainers are hooked to one power source. It is stored in the distribution box.

(i) Target assemblies (9 and 10, fig 1-2). The target assemblies are aluminum cored retroreflective reversible targets with tank silhouettes on each side that are used in moving target training exercises.

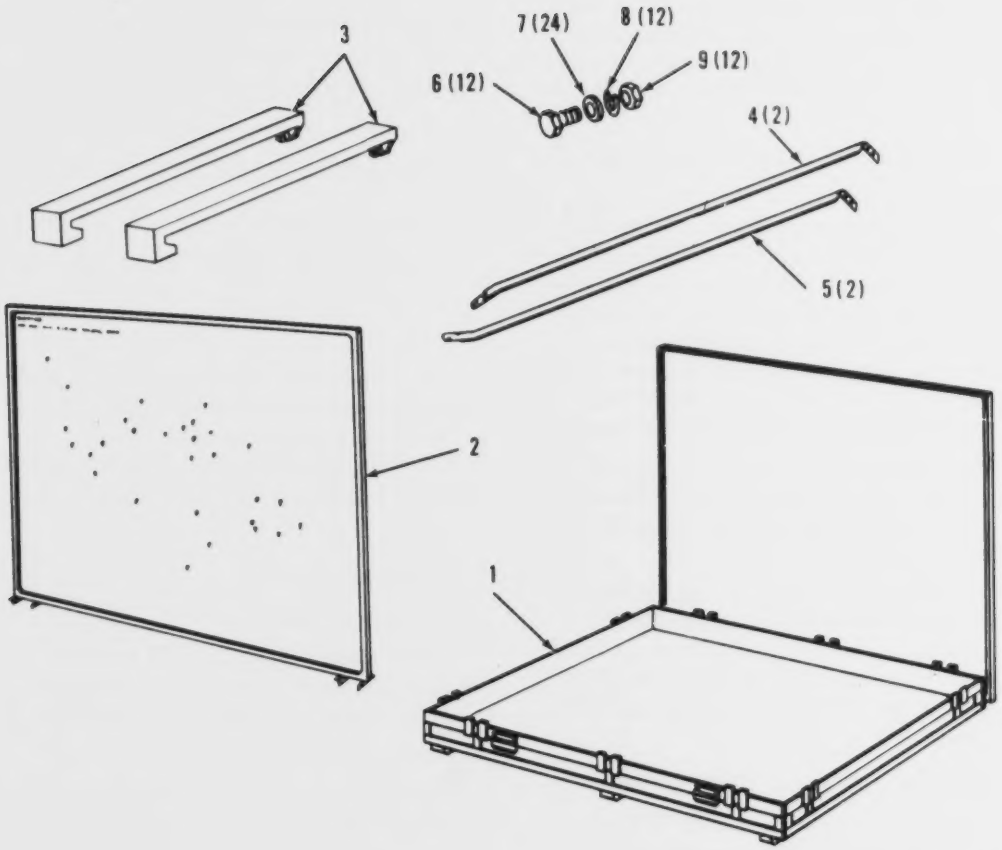
(j) Target assemblies (11 and 12, fig 1-2). The targets are eight inch aluminum disks that are hung on a target board. Both are used as stationary targets. The target assembly (laser) (12) is a retroreflective target for the laser. The target assemblies (boresight) (11) are painted with black quadrants and clear aluminum quadrants in between.



Legend for fig 1-6.

1. LANYARD switch - 11746480
2. Cable assembly (10 ft) - 11746454
3. Adapter cable assembly - 11747152
4. Distribution box - 11746450
5. Boresight target assembly (3) - 11746461
6. Laser target assembly - 11746464
7. Deflector optical assembly - 11746410
8. Mount - 11746495
9. Cable assembly (20 ft) (3) - 11746452
10. Cable assembly - 11747170
11. Adapter assembly for M114A1/M114A2 howitzer - 11747146
12. Target assembly, moving - 11746475
13. Deflection tables - 11747153, 11747154, 11747155, 11747156, 11747164
14. Target assembly, stationary - 11746468
15. Control rods (2) - 11746446

Figure 1-6. ADFT in case



Legend for fig 1-7.

1. Shipping container - 11747167
2. Target support assembly - 11746502
3. Base assembly (2) - 11746509
4. Support, left, target (2) - 10554643-1
5. Support, right, target (2) - 10554643-2
6. Screw (12) - MS35307-308
7. Washer, flat (24) - MS15795-810
8. Washer, lock (12) - MS35333-74
9. Nut, plain, hexagon (12) - MS35649-2254

Figure 1-7. ADFT target support assembly with shipping and storage container

(k) Deflection tables (13, 14, 15, 16, 17, and 18, fig 1-2). The deflection tables are used to compensate for ballistic corrections at various ranges. The data in the deflection tables simulates one-tenth (1/10) of the actual range. Therefore, a parallax correction has been made in the azimuth plane. Elevation settings will correspond to the simulated ranges. Elevation correction data is provided as an azimuth change will cause the laser beam, as viewed on the target, to change in elevation.

(l) Operator's manual TM 9-6920-357-10-2 (19, fig 1-2).

(m) Cable assembly (20 ft) (20, fig 1-2). Three are provided. Any one of these cable assemblies can connect the distribution box connector (J3) to the power connector (J4) on the control box assembly (fig 2-10). Two cables can be connected with the adapter cable when required. Any one of these cables can (using the adapter cable) connect the 10 foot cable assembly to the distribution box when required.

(n) M109 cable assembly (21, fig 1-2). This cable connects the power connector (J4) on the control box assembly to the collimator outlet on the M109/M109A1 howitzer.

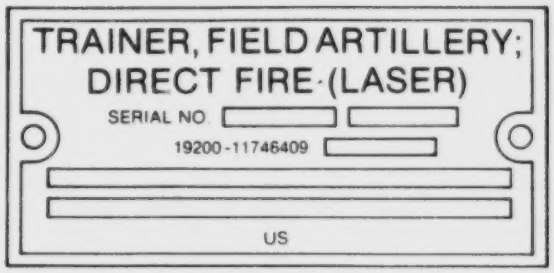
(o) Control rods (22, fig 1-2). Control rods are attached to the elevation and deflection knobs of the deflector assembly only when mounted on the 155-mm Howitzer M109/M109A1; thus serving as extension arms and providing access to elevation and deflection scales.

(3) *Equipment packed in shipping container.*

(a) Target support assembly (2, fig 1-7). A welded assembly of aluminum channels is used to support the target assembly. Supports are used to maintain the target board upright. The target board consists of an aluminum sheet with retroreflective sheeting on front and back surfaces with keyhole openings to attach target assemblies for boresighting and tracking.

(b) Base assembly (3, fig 1-7). Aluminum rails with hooks at one end and a wedge at the other are used to attach the support assembly and supports to cargo trailer M416 during boresighting and training exercises.

(4) *Identification plate (fig 1-8).* The ADFT has an identification plate mounted on the top surface of the deflector optical assembly. The plate contains the official nomenclature, serial number, month and year of manufacture, manufacturer code identification, and part number. In addition, two blank spaces are provided for the inclusion of supplemental data.



AR 911786

Figure 1-8. ADFT identification plate

d. *Component Description.* If you need a detailed description of any component of the laser or ADFT, ask your supervisor to see TM 9-6920-357-24&P which contains applicable organizational maintenance information.

1-6. Tabulated Data.

Power Requirements:

Input voltage	24 ± 6 vdc
Input current (nominal)	1.3 amperes
Input current (maximum)	3 amperes

Operating Characteristics:

Modes of operation	Continuous and flash
Power output	0.5 to 2.0 milliwatts (nominal)
Beam diameter	Approximately 5/8 inch (16 millimeters) at 200 feet (61 meters)
Flash duration	100 ± 25 milliseconds
Repetition rate	Retriggerable 200 milliseconds after release of trigger

Temperature:

Operating	0°F (-18°C) to +100°F (+56°C)
Nonoperating (storage)	-65°F (-54°C) to +155°F (+86°C)

Altitude:

Operating	Sea level to 10,000 feet (3,048 meters)
Nonoperating (transporting)	Sea level to 50,000 feet (15,240 meters)

Carrying Case, Trainer:

Material	Laminated aluminum with wooden core
Dimensions	46 inches (117 centimeters) long 28 inches (71 centimeters) wide 18 inches (46 centimeters) deep
Cushioning material	Polyethylene foam
Weight (empty)	57 pounds (26 kilograms)
Weight (with equipment)	143 pounds (65 kilograms)
Color	Olive drab
Handles	Four
Latches	Eight

Container, Shipping and Storage:

Material	Plywood, reinforced
Dimensions	78.25 inches (198.76 centimeters) long 61.5 inches (156.21 centimeters) wide 11.25 inches (28.58 centimeters) deep
Weight (empty)	200 pounds (91 kilograms)
Weight (with equipment)	298 pounds (135.17 kilograms)
Color	Olive drab
Handles	Four
Latches	Ten

CHAPTER 2
OPERATING INSTRUCTIONS

Section I. OPERATING INSTRUCTIONS

2-1. **Controls and Indicators.** Controls and indicators are listed in table 2-1 and are illustrated in figures 2-5, 2-6, and 2-10.

Table 2-1. Controls and Indicators

Key	Control/Indicator	Function
Figure 2-6, Item 1	LASER SAFE FIRE circuit breaker CB1.	Two-position circuit breaker which is connected in series with the power cable. SAFE position - prevents power from being applied to the trainer. FIRE position - enables a 24 vdc input to fire the laser.
Figure 2-6, Item 2	MODE CONT FLASH switch S1.	Two-position toggle switch which establishes the mode of operation of the trainer. CONT position - timing module is disabled and the high voltage power supply is activated continuously when 24 vdc is applied. FLASH position - activates the timing module which disables the high voltage power supply after 100 milliseconds. This limits the laser output to one flash of 100 milliseconds duration each time 24 vdc is applied.
Figure 2-6, Item 3	TRIGGER ON indicator lamp DS1.	When illuminated, indicates that 24 vdc is applied to the trainer.
Figure 2-6, Item 4	LASER ON indicator lamp DS2.	When illuminated, indicates that the laser tube is activated and the trainer is emitting a beam of light.
Figure 2-5, Item 1	AZ (Azimuth) knob	Moves Laser beam on retroreflective target in an Azimuth plane.
Figure 2-5, Item 2	EL (elevation) knob	Moves Laser beam on retroreflective target in elevation/depression.

Table 2-1. Controls and Indicators (Continued)

Key	Control/Indicator	Function
Figure 2-10.	BORESIGHT OFF FIRING switch	Three-position switch. OFF position - prevents power from being applied to the trainer. BORESIGHT position - switch must be held in this position when trainer is being boresighted. FIRING position - enables the trainer to be fired by the LANYARD switch. Switch locks into this position.
Figure 2-4.	Alignment indicator	When aligned, indicates mid-position of mirror assembly travel prior to boresighting.

2-2. **Installation of Target.**

WARNING

Flat, specular reflective surfaces, such as the side reflector on the M416 1/4 ton trailer, shall be covered or masked to prevent reflection back to the howitzer crew.

a. Place the two base assemblies (2, fig 2-1) across the width of the trailer in the same direction with their hook ends snug under the rounded lip of the trailer. Advance wedge using knob under opposite side of trailer but do not secure.

b. Place target support assembly (1) upright across the two base assemblies (2) with the target support assembly (1) located in the guides on each base assembly. Assemble four supports (3 and 4) using fastening hardware. Secure base assemblies to trailer using knob to advance wedge under rounded edge of trailer and turn nut in against wedge to lock in place.

c. After training, reverse the assembly procedures for disassembly and place in storage container.

NOTE

The target board has been inserted into frame assembly to form the target support assembly (1). Target support assembly always remains assembled during training and storage.

2-3. **105-mm Howitzer M101A1.**

a. *Installation (Fig 2-2).*

(1) Install mount assembly (1) on the recuperator cylinder of the recoil mechanism three inches ± 1/2 inch in front of the rear yoke, measured from the clamp jaw.

NOTE

The hand knob (2) must be on the right side of the mount with viewer facing the howitzer breech.

(2) Center the bubble in the front level vial assembly (3) attached to the mount assembly ± 1/2 vial graduation.

(3) Carefully tighten hand knob (2) and recheck the bubble.

CAUTION

Do not remove lens guard (2, fig 2-3) from laser until ready to install deflector optical assembly.

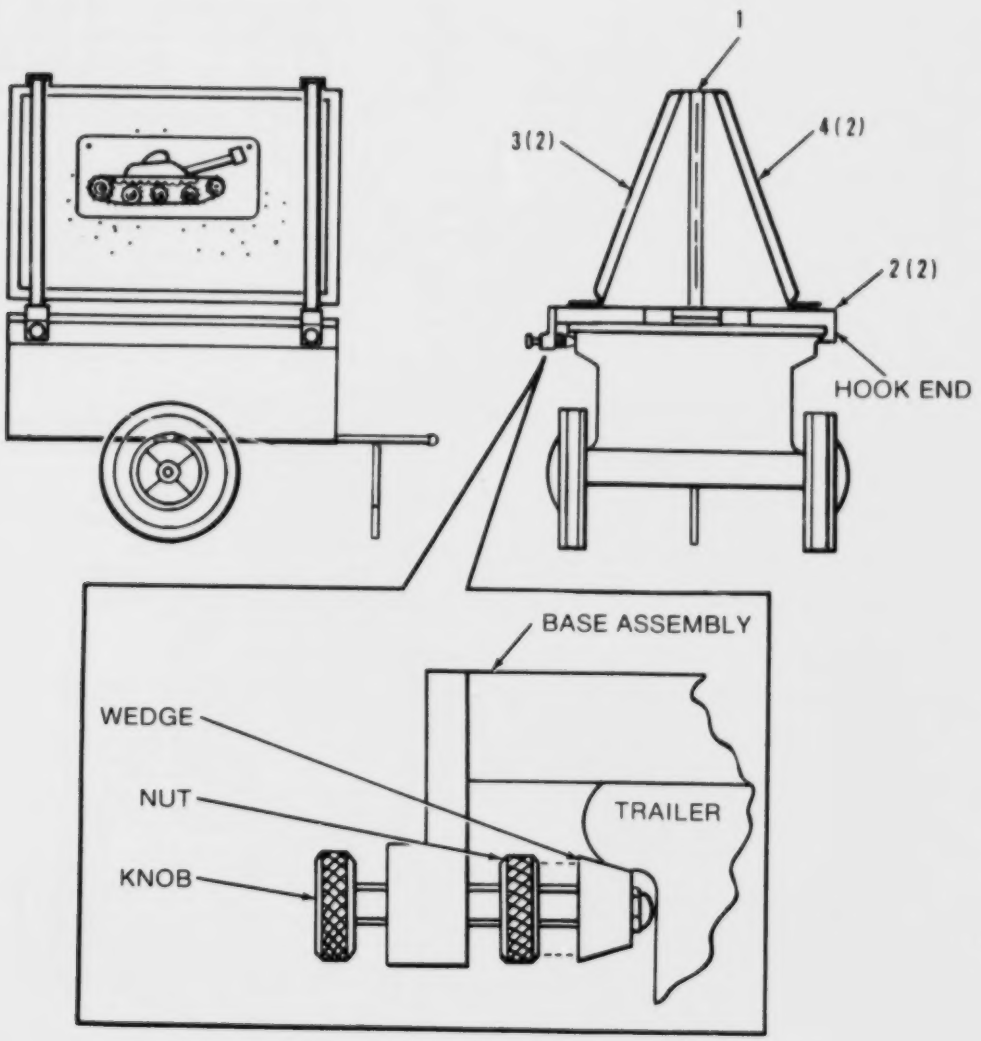
(4) Open the clamp (4, fig 2-2) on the mount (12) using the hand knob (5), and insert the laser (6) with the lens guard (2, fig 2-3) facing the muzzle of the howitzer. Key projections on the laser match the grooves in the clamp.

(5) Cross-level the laser using the gunner's quadrant M1 (weapon BII) (1, fig 2-3), placed on left side of laser six inches ± 1/2 inch from the rear. Tighten knob (5, fig 2-2).

(6) Remove the lens guard (2, fig 2-3) and retain.

(7) Attach the deflector optical assembly (7, fig 2-2) to the laser; turn thumbscrew (8) until light contact is made with the laser, then back off one-half turn. Screw the adapter (9) snugly onto the end of the laser.

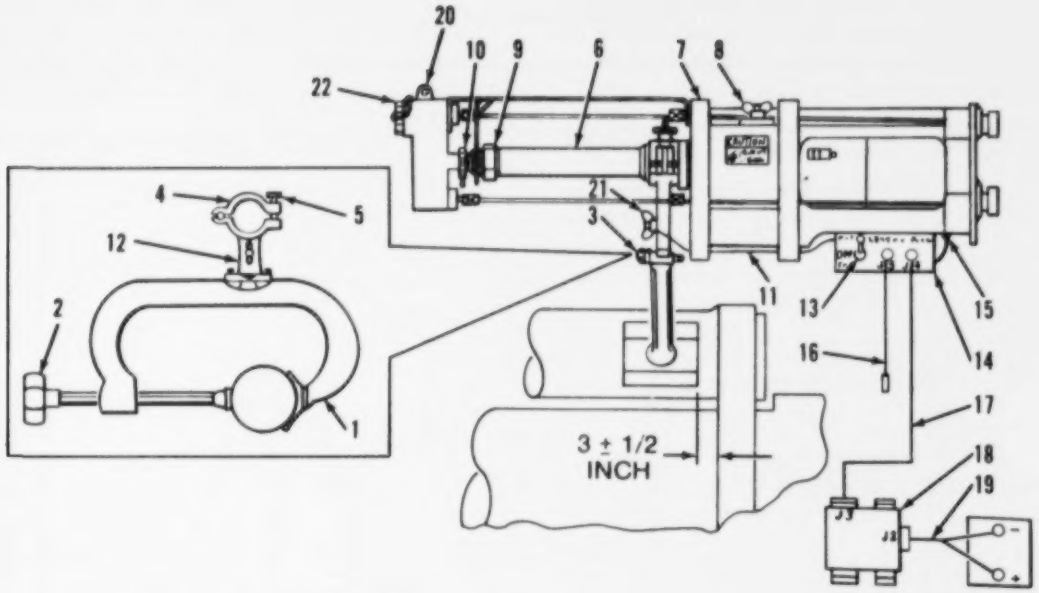
(8) Tighten thumbscrew (8).



Legend for fig 2-1.

1. Target support assembly - 11746502
2. Base assembly (2) - 11746509
3. Left support (2) - 10554643-1
4. Right support (2) - 10554643-2

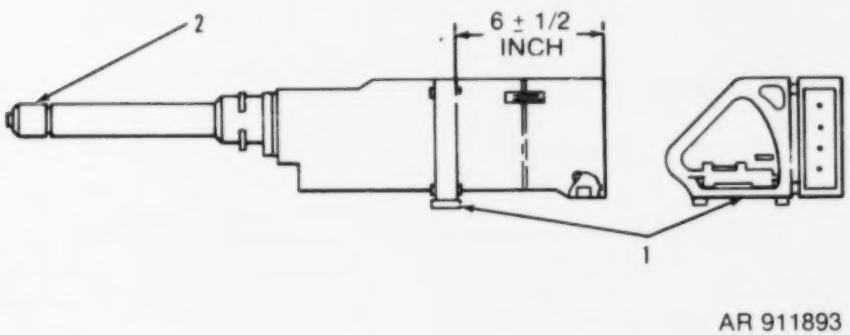
Figure 2-1. Trailer mounted target



Legend for fig 2-2.

1. Mount assembly - 11747147
2. Hand knob - 11746500
3. Level vial assembly - 11736260
4. Clamp - 11746496
5. Hand knob - 11746499
6. Gunnery trainer laser M55 - 11741700
7. Deflector optical assembly - 11746410
8. Thumbscrew - 11746417
9. Adapter - 11746423
10. Ring - 11746424
11. Ground wire
12. Mount - 11746495
13. BORESIGHT OFF FIRING switch - MS24612-312K
14. Control box assembly - 11746456
15. Power cable assembly
16. LANYARD switch - 11746480
17. Cable assembly (20 ft) - 11746452
18. Distribution box - 11746450
19. Cable assembly (10 ft) - 11746454
20. Fire control level vial - 8626161
21. Wing nut - MS35425-37
22. Plug assembly - 11748075

Figure 2-2. Installation of laser and trainer on 105-mm M101A1 howitzer



Legend for fig 2-3.

1. Gunner's quadrant M1
2. Lens guard - 11741679

Figure 2-3. Alignment of laser with gunner's quadrant M1 series

(9) Level deflector optical assembly (7) using fire control level vial (20).

(10) Tighten ring (10) against adapter (9).

(11) Align the arrow (1, fig 2-4) on the alignment indicator housing with the scribe mark (2) on the azimuth control shaft (3).

(12) Rotate elevation control shaft (6) fully counterclockwise, then rotate the elevation control shaft clockwise until the scribe mark (5) is aligned with the arrow (4).

(13) Hold the elevation knob (2, fig 2-5) and slip scale to zero. Hold the azimuth knob (1) and slip the scale to zero.

(14) Secure ground wire (11, fig 2-2) to the mount (12) with wing nut (21).

WARNING

Be sure that LASER SAFE FIRE circuit breaker (1, fig 2-6) is set to the SAFE position and BORESIGHT OFF FIRING switch is in the OFF position.

(15) Connect power cable assembly (15, fig 2-2) to receptacle 1J1 on the underside of the laser.

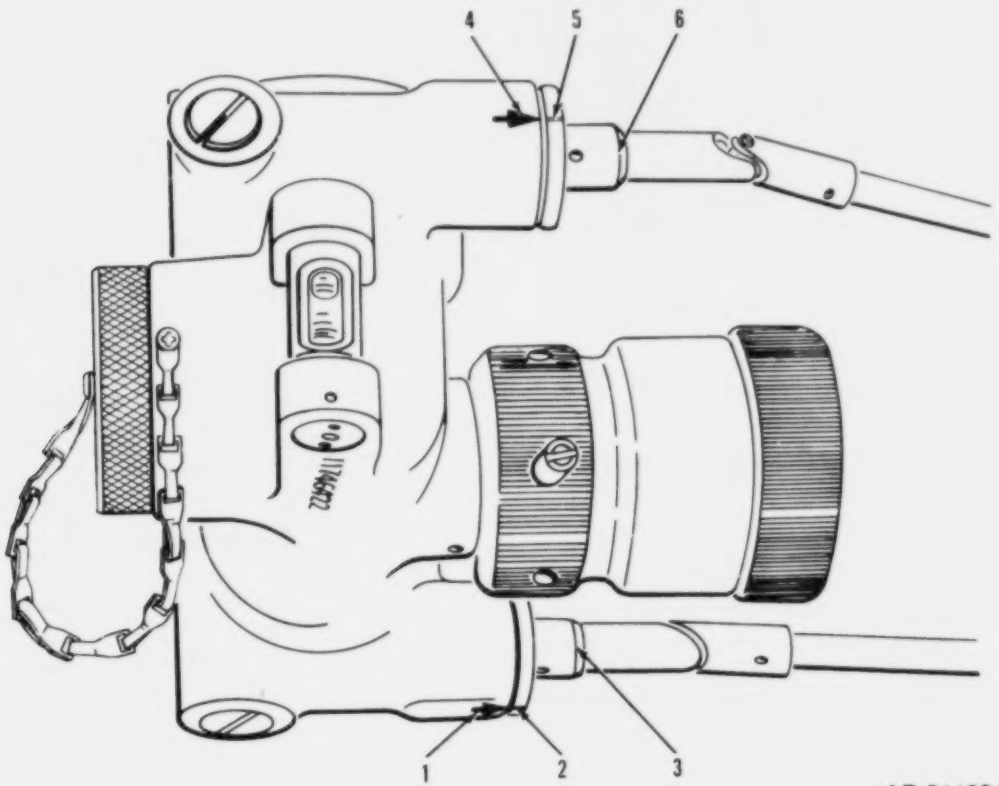
CAUTION

Be sure the cable of the lanyard switch (16) is positioned so that it will not be damaged during operation of the howitzer.

(16) Connect the lanyard switch (16) connector to connector J5 on the control box assembly (14). Attach the lanyard switch snap just behind the knob on the weapon lanyard.

(17) Attach one cable assembly (20 ft) (17) to connector J3 on the distribution box (18) and to connector J4 on control box assembly (14).

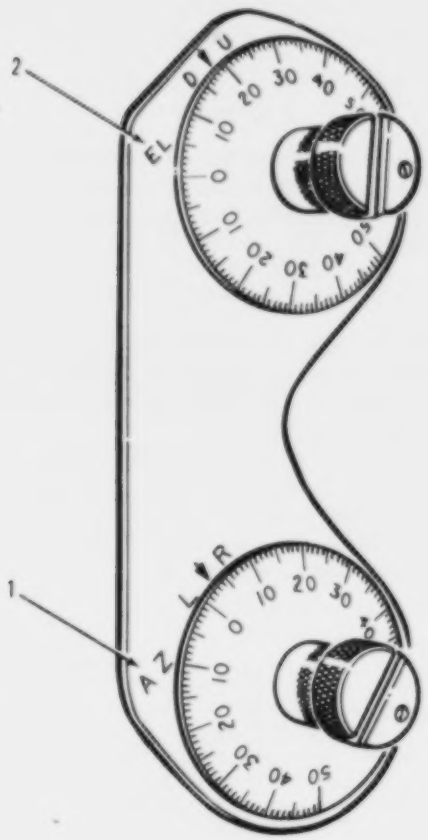
(18) Attach cable assembly (10 ft) (19) to connector J2 on distribution box (18).



Legend for fig 2-4.

1. Arrow (azimuth)
2. Scribe mark (azimuth)
3. Azimuth control shaft
4. Arrow (elevation)
5. Scribe mark (elevation)
6. Elevation control shaft

Figure 2-4. Alignment indicator



Legend for fig 2-5.
1. Azimuth (AZ) knob
2. Elevation (EL) knob

Figure 2-5. Azimuth and elevation knobs

NOTE

If necessary one cable assembly (20 ft) (17) and adapter cable assembly (8, fig 1-2) can be installed between the cable assembly (10 ft) (7) and the distribution box (18, fig 2-2).

CAUTION

Red color insulated clip goes to the positive (+) terminal of the 24 vdc power supply and the black goes to the negative (-) terminal. Do not reverse polarity.

(19) Clip the cable assembly (10 ft) (19) to the 24 vdc power supply.

(20) If necessary the cable assemblies (20 ft) (fig 2-7) and the adapter cable assembly (fig 2-7) may be used to connect to the distribution box (fig 2-7) for multiple weapon operation (fig 2-7).

(21) Remove plug assembly (22, fig 2-2).

b. *Boresighting (for Training Purposes Only. See Paragraph 1-4) (Fig 2-8).*

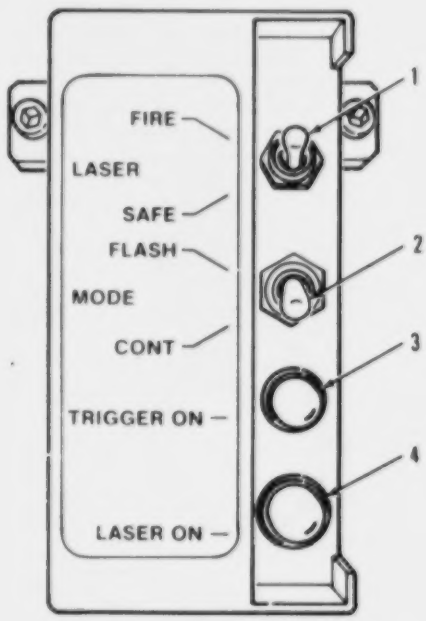
(1) Emplace weapon. Place a pretested gunner's quadrant (3, fig 2-8) in breech (4) and check the amount of cant. Level trunnions to 90 mils cant, or less.

(2) Install breech boresight (howitzer BII) (1).

(3) Fasten crosshairs (2) to muzzle.

(4) Place the trailer mounted target (fig 2-1) on level terrain facing the cannon bore fifty meters in front of the deflector optical assembly (7, fig 2-2).

(5) Place three target assemblies (11, fig 1-2) and one target assembly (12) in their proper slots on target support assembly (1, fig 2-1).



Legend for fig 2-6.
1. LASER SAFE FIRE circuit breaker switch
2. MODE CONT FLASH switch
3. TRIGGER ON indicator lamp
4. LASER ON indicator lamp

Figure 2-6. Rear control panel

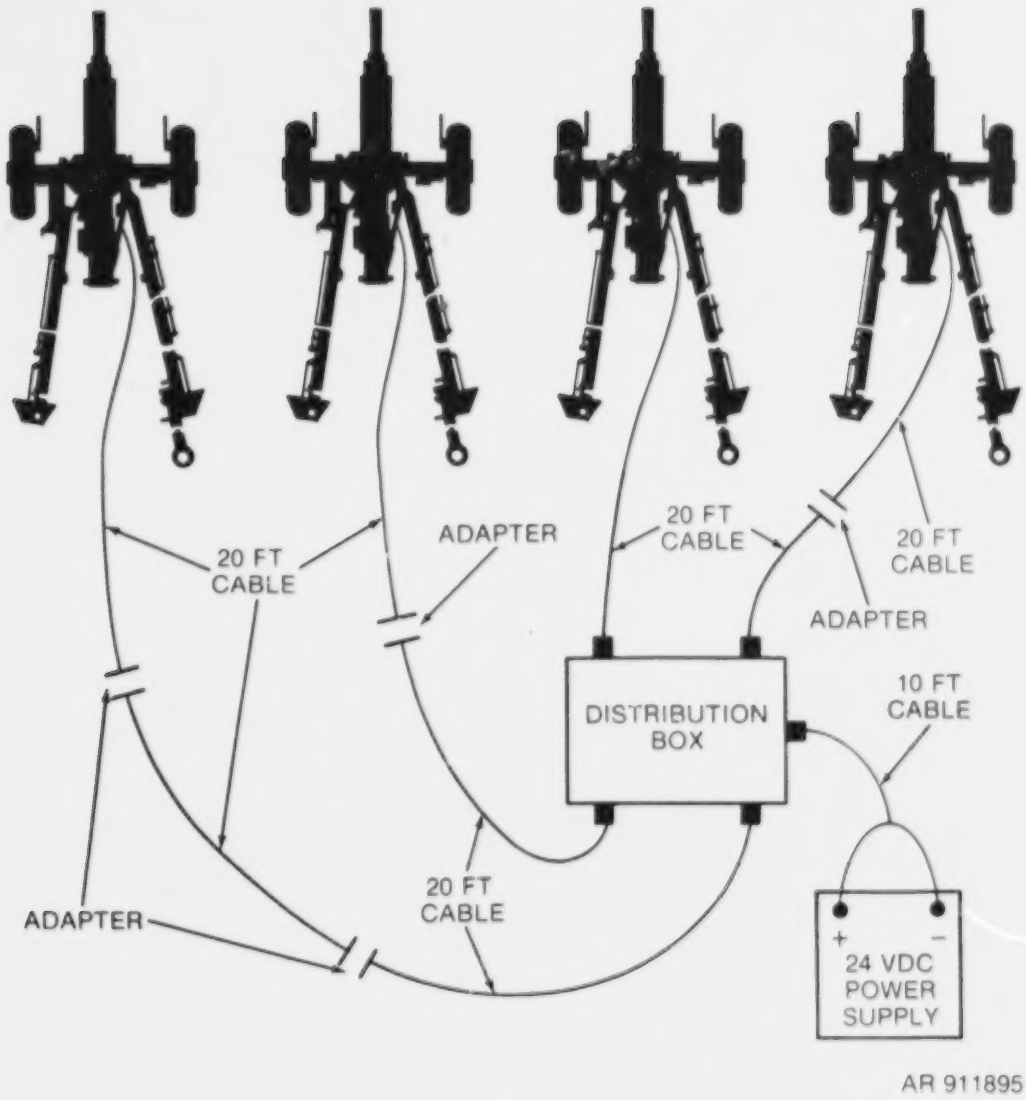
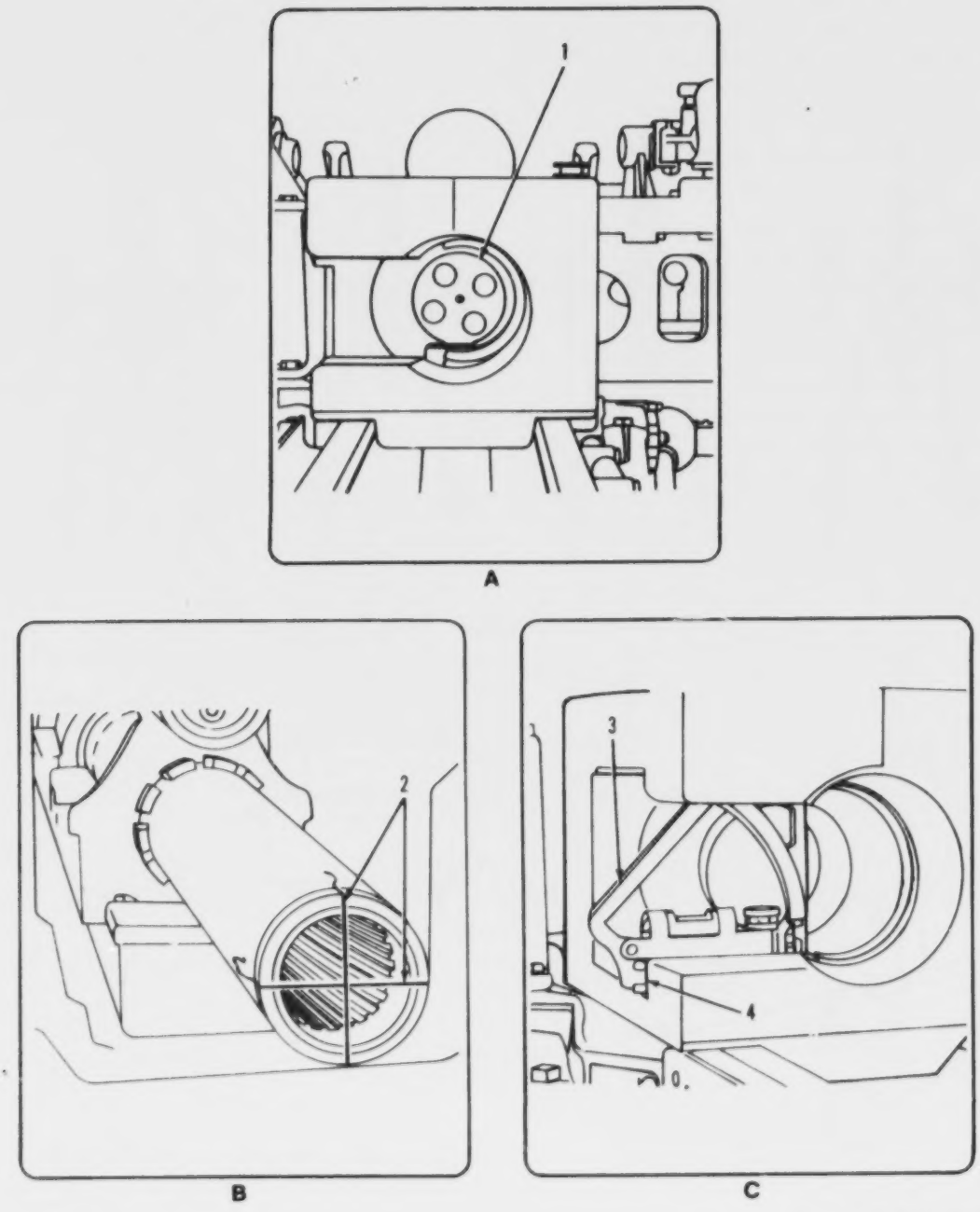


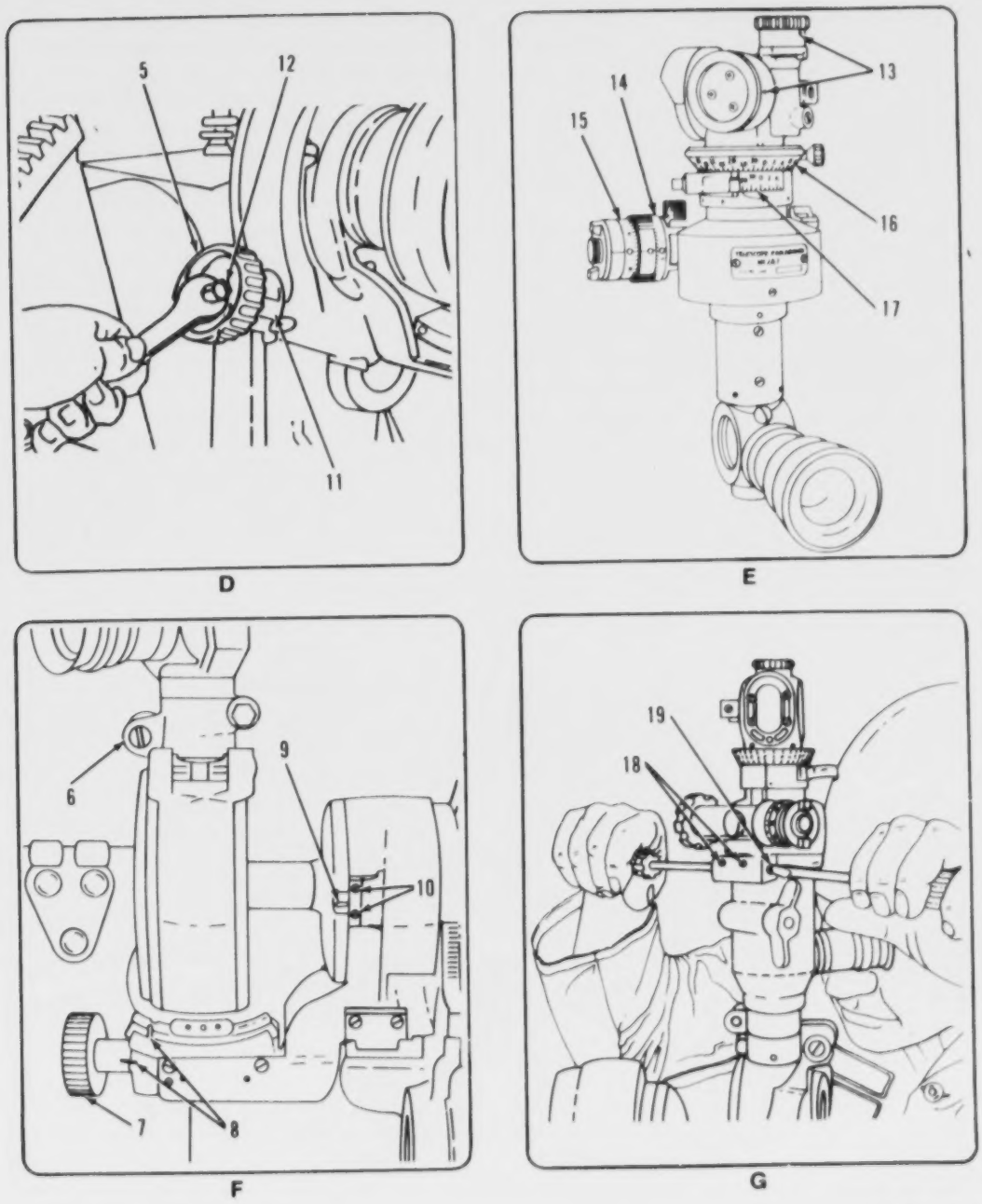
Figure 2-7. Multiple weapon operation



Legend for fig 2-8.

1. Breech boresight
2. Crosshairs
3. Gunner's quadrant M1 series
4. Breech

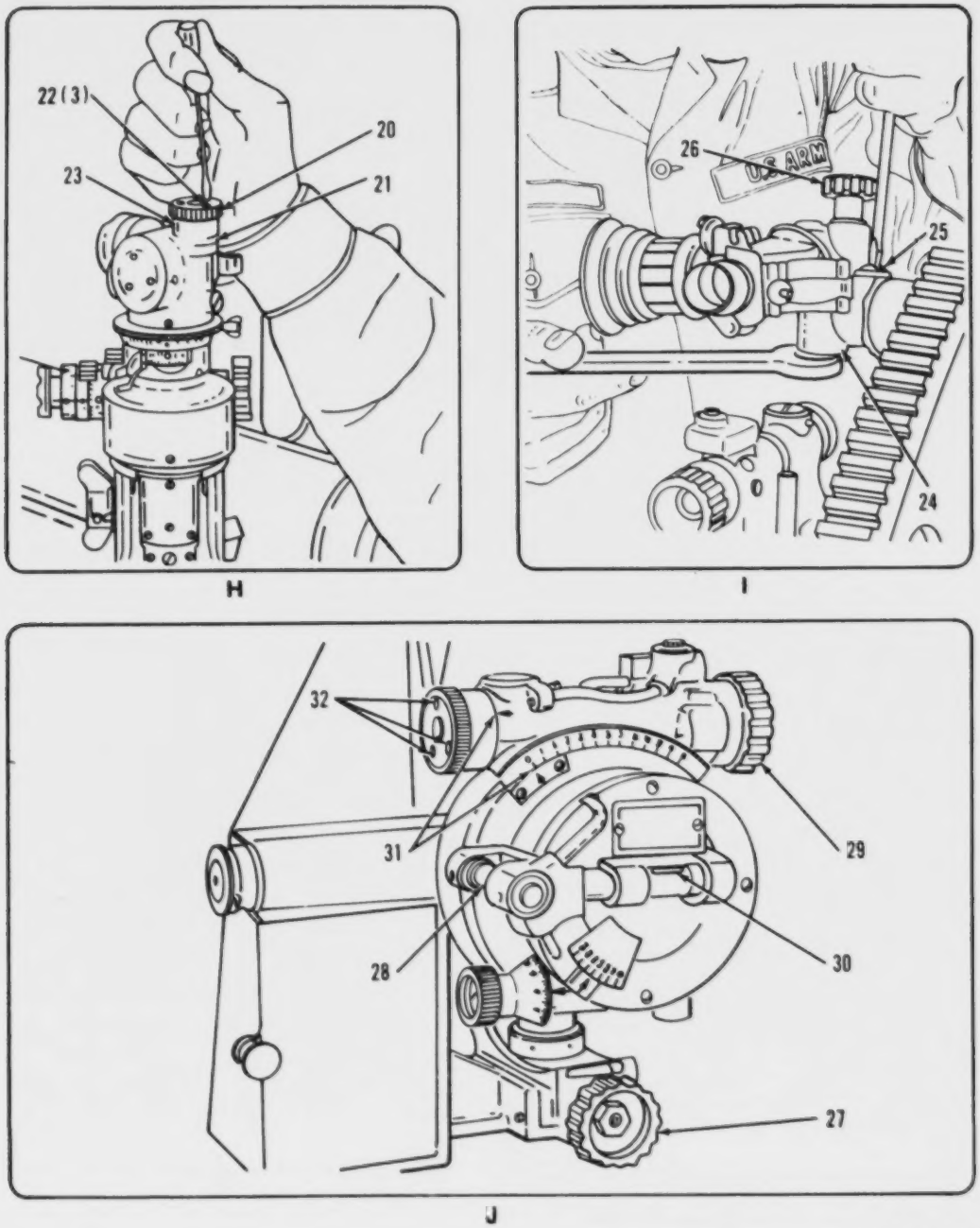
Figure 2-8. Boresighting M101A1 howitzer (1 of 3)



Legend for fig 2-8 - Continued.

5. Longitudinal leveling knob
6. Longitudinal level bubble
7. Cross leveling knob
8. Cross level scribe marks
9. Coarse longitudinal index
10. Screw
11. Fine longitudinal index
12. Nut
13. Coarse and fine elevation indexes
14. Gunner's aid scale
15. Micrometer index scale
16. Slipping azimuth scale
17. Nonslipping azimuth scale
18. Tangent locking screws
19. Tangent screws

Figure 2-8. Boresighting M101A1 howitzer (2 of 3)



Legend for fig 2-8 - Continued.

20. Elevation knob
21. Fine elevation index
22. Screws (3)
23. Zero scale (not shown)
24. Clamping bolt
25. Elevation worm
26. Bracket rotating knob
27. Cross leveling worm knob
28. Cross level bubble
29. Elevation knob
30. Longitudinal level bubble
31. Elevation scale and micrometer
32. Screws (3)

Figure 2-8. Boresighting M101A1 howitzer (3 of 3)

(6) Sighting through the breech boresight (1, fig 2-8) elevate the howitzer to align the muzzle crosshairs with the test target diagram on the cannon target (1, fig 2-9). If azimuth corrections are necessary, move the trailer mounted target as necessary.

(7) Using the longitudinal leveling knob (5, fig 2-8) on the telescope mount M21A1, center the longitudinal level bubble (6).

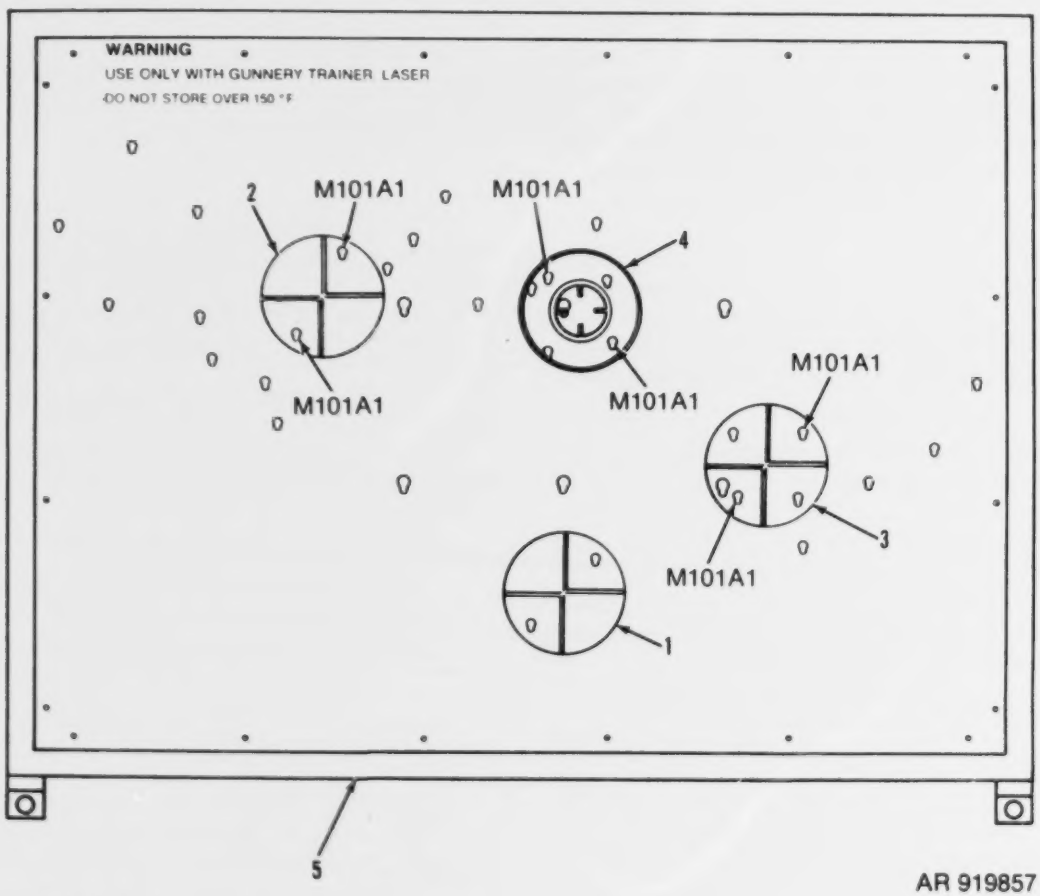
(8) Using the cross leveling knob (7), align the cross level scribe marks (8).

(9) Check the coarse longitudinal index (9) for proper alignment. If not aligned, loosen two screws (10) and move the coarse longitudinal index until properly aligned. Tighten two screws and recheck alignment.

(10) Check the fine longitudinal index (11) for alignment. If not aligned, loosen nut (12) and slip fine longitudinal index until properly aligned. Tighten nut and recheck alignment.

(11) Align the pantel coarse and fine elevation indexes (13) and zero the gunner's aid scale (14), the azimuth micrometer index scale (15), the slipping azimuth scale (16), and the nonslipping azimuth scale (17).

(12) Look through the pantel eyepiece. If the vertical reticle line in the pantel is not aligned with the vertical line of the test target diagram of M12A7S pantel target (2, fig 2-9), loosen the tangent locking screws (18, fig 2-8) on the telescope socket and adjust the tangent screws (19) until the vertical line is properly aligned. Tighten the tangent locking screws and recheck alignment.



Legend for fig 2-9.

1. Cannon target - 11746461
2. M12A7S pantel target - 11746461
3. M16A1D telescope target - 11746461
4. Laser target - 11746464
5. Target support assembly

Figure 2-9. Installation of boresight targets for 105-mm M101A1 howitzer

(13) Look through the eyepiece. If the horizontal reticle line is not aligned with the test target diagram (2, fig 2-9), the elevation knob (20, fig 2-8) must be adjusted. Turn the elevation knob until the horizontal reticle line is properly aligned. Check to see if the fine elevation index (21) is aligned. If it is not, loosen three screws (22) and turn the elevation knob until the zero (23) and the fine elevation index are aligned. Tighten the three screws and recheck alignment.

(14) Without moving the tube or test target, look through the direct fire telescope. The N line of the direct fire telescope should be aligned with the horizontal line of the test target diagram of the M16A1 telescope target (3, fig 2-9).

(15) If necessary, adjust the N line by loosening the clamping bolt (24, fig 2-8), and using a screwdriver to turn the elevation worm (25) until the N line is properly aligned. Tighten clamping bolt. If the reticle pattern appears tilted in relation to the horizontal line, turn the bracket rotating knob (26), until the N line is horizontal.

(16) Using the cross leveling worm knob (27), center the cross level bubble (28). Then, using the elevation knob (29), center the longitudinal level bubble (30).

(17) The elevation scale and elevation micrometer (31) should read 0. If not, loosen three screws (32). Without moving the knob, slip the zero of the elevation micrometer into alignment with the index. Tighten three screws and recheck alignment.

WARNING

Make sure all safety precautions are taken prior to operating the laser.

NOTE

The laser requires from thirty seconds to thirty minutes to warm up.

(18) Set laser MODE CONT FLASH switch (2, fig 2-6) to CONT.

(19) Set LASER SAFE FIRE circuit breaker (1) to FIRE.

(20) Hold BORESIGHT OFF FIRING switch (fig 2-10) in BORESIGHT position as long as necessary to complete the boresight procedures.

NOTE

The laser TRIGGER ON (3, fig 2-6) and LASER ON (4) indicator lamps illuminate as long as the BORESIGHT OFF FIRING switch (fig 2-10) is held in the BORESIGHT position.

(21) Turn AZ knob (1, fig 2-5) and EL knob (2) until the laser beam is centered on target (4, fig 2-9). Slip both scales to zero.

NOTE

Check that at least 45 mils down deflection and 27 mils azimuth movement remain. If not, notify organizational maintenance.

(22) Release BORESIGHT OFF FIRING switch (fig 2-10). It is spring loaded and will return automatically.

(23) Set LASER SAFE FIRE circuit breaker (1, fig 2-6) to SAFE.

(24) Set laser MODE CONT FLASH switch (2) to FLASH.

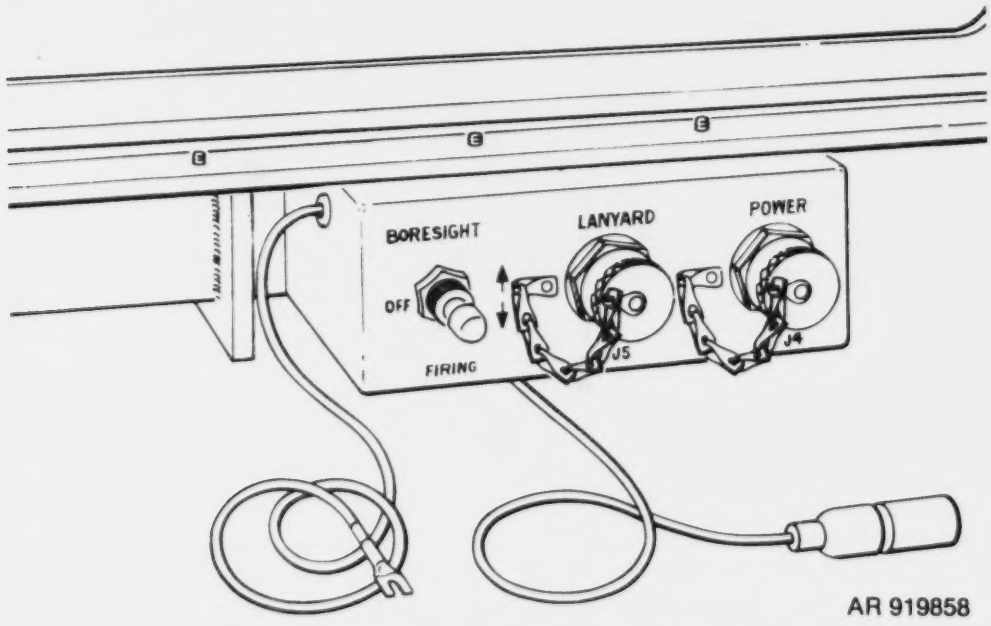


Figure 2-10. Control box with BORESIGHT OFF FIRING switch

WARNING

If the laser trainer is not to be immediately operated, the power supply should be disconnected to prevent accidental firing of the laser.

c. *Checkout Prior to Operation.*

WARNING

Before proceeding, make sure the LASER SAFE FIRE circuit breaker (1, fig 2-6) is set to SAFE and the TRIGGER ON indicator lamp (3) is not illuminated.

(1) With the laser and deflector optical assembly installed and ready for operation, proceed as follows: LASER SAFE FIRE circuit breaker (1) set to SAFE, MODE CONT FLASH switch set to CONT, BORESIGHT OFF FIRING switch (fig 2-10) set to BORESIGHT and held. Observe that TRIGGER ON indicator lamp (3, fig 2-6) illuminates.

(2) Place the BORESIGHT OFF FIRING switch (fig 2-10) in FIRING position and MODE CONT FLASH switch (2, fig 2-6) in FLASH position. Pull on LANYARD switch (16, fig 2-2) and observe that TRIGGER ON indicator lamp (3, fig 2-6) illuminates.

(3) Place the LASER SAFE FIRE circuit breaker (1) in FIRE position. While observing the target, note that a shot of laser light is emitted each time that either the BORESIGHT OFF FIRING switch (fig 2-10) is pressed or LANYARD switch (16, fig 2-2) is pulled.

(4) Set the LASER SAFE FIRE circuit breaker (1, fig 2-6) to SAFE.

(5) Set the BORESIGHT OFF FIRING switch (fig 2-10) to OFF.

WARNING

If the laser is not to be immediately operated, the power supply should be disconnected to prevent accidental firing of the laser.

d. *Operation.*

(1) Remove all target assemblies (1,2,3,4, fig 2-9) from target support assembly (5). Mount tank silhouette targets (1,2, fig 2-11), one on each side of target board, at their designated locations on the target support assembly (5, fig 2-9) and secure together with quick disconnect pin (3, fig 2-11) attached to target (1).

(2) Normal firing procedures, designated in TM 9-1015-203-12, will be followed with the instructor making all the deflector assembly adjustments (app D). For this training exercise the 105-mm Howitzer M101A1 deflection table (fig 2-12) will be used for parallax correction, and for all inputs at all applicable ranges. Refer to applicable portions of the deflection table for moving target training instructions and inputs.

(3) Set the laser MODE CONT FLASH switch (2, fig 2-6) to FLASH.

(4) Set the LASER SAFE FIRE circuit breaker (1) to FIRE.

(5) Set the BORESIGHT OFF FIRING switch (fig 2-10) to the FIRING position. Pull the LANYARD switch (16, fig 2-2) as required by the training exercise and the laser will emit one shot of laser light visible on the retroreflective target for each pull. The laser TRIGGER ON (3, fig 2-6) and LASER ON (4) indicator lamps illuminate each time the LANYARD switch (16, fig 2-2) is pulled.

(6) After completion of exercise, set the LASER SAFE FIRE circuit breaker (1, fig 2-6) to SAFE and the BORESIGHT OFF FIRING switch (fig 2-10) to OFF.

WARNING

If the laser is not to be immediately operated, the power supply should be disconnected to prevent accidental firing of the laser.

e. *Removal of Laser.*

WARNING

Make sure the LASER SAFE FIRE circuit breaker (1, fig 2-6) is set to SAFE and the BORESIGHT OFF FIRING switch (fig 2-10) is set to OFF.

(1) Install plug assembly (22, fig 2-2).

(2) Disconnect cable assembly (10 ft) (19) from power source and from distribution box (18).

(3) Disconnect cable assembly (20 ft) (17) and adapter cable assembly (8, fig 1-2), if used, from distribution box (18, fig 2-2) and control box (14).

(4) Disconnect LANYARD switch (16) from weapon lanyard and control box (14).

(5) Disconnect cable assembly (15) from IJ1 receptacle on the underside of the laser.

(6) Loosen wing nut (21) and remove ground wire (11) from mount (12).

(7) Loosen thumbscrew (8) until light contact is maintained, unlock ring (10), and unscrew adapter (9).

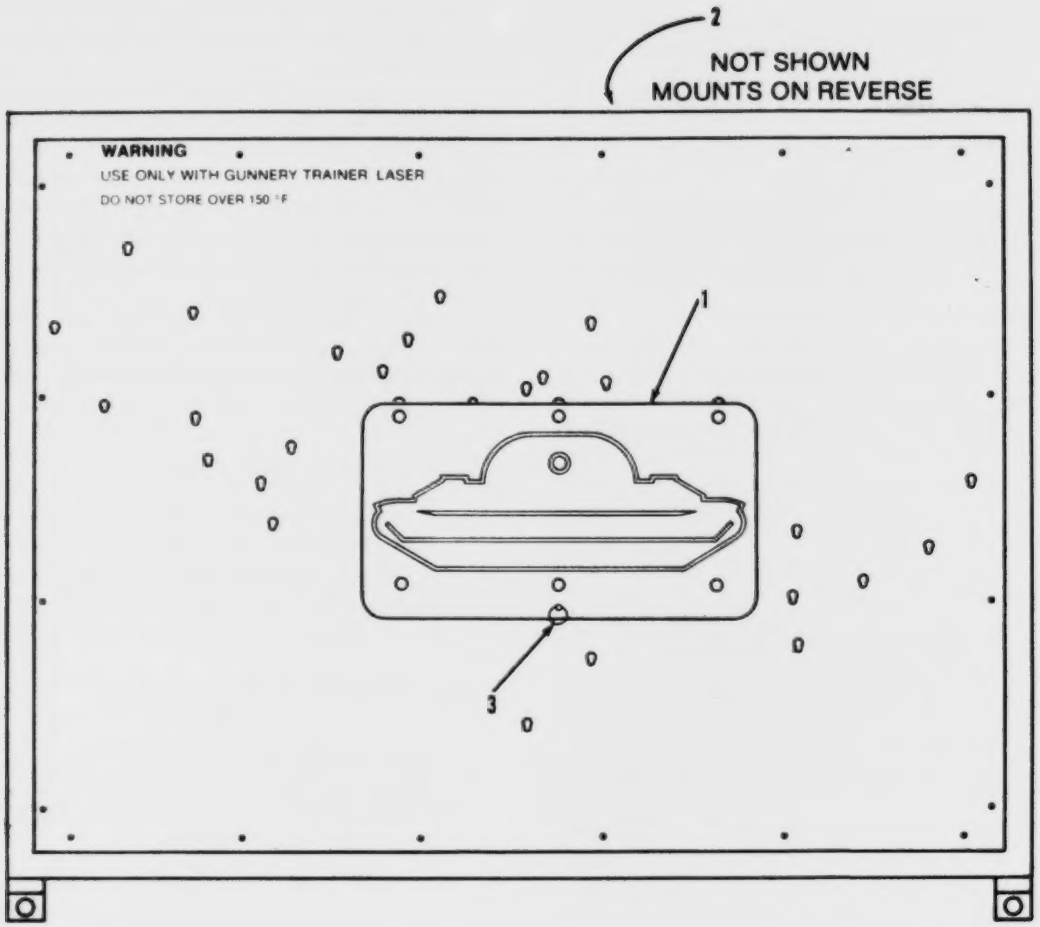
(8) Loosen thumbscrew (8) completely and remove deflector optical assembly (7).

(9) Install lens guard (2, fig 2-3) on laser.

(10) Loosen hand knob (5, fig 2-2), open clamp (4) (leave clamp open for storage), and remove laser.

(11) Loosen hand knob (2) and remove mount assembly (1).

(12) Perform after firing PMCS and pack laser and trainer in their respective carrying cases and storage containers.



Legend for fig 2-11.

1. Target, moving - 11746475
2. Target, stationary (not shown) - 11746468
3. Pin - MS17987-C306

Figure 2-11. Installation of tank silhouette targets on trailer mounted target for 105-mm M101A1 howitzer

DEFLECTION TABLE
LASER TRAINER M55
(ARTILLERY APPLICATION)

105 MM HOW. M101A1

AMMUNITION: HE CH7
HEP-T

Mounting Location: Recoil Mechanism. Rear of Gun

RANGE IN METERS		DEFLECTOR SETTINGS		
SIMULATED	ACTUAL	HORIZONTAL	VERTICAL D	
		L	HE CH7	HEP-T
400	40	10.5	16.0	13.5
500	50	8.5	17.0	14.0
600	60	7.0	19.0	15.0
700	70	6.0	21.0	16.5
800	80	5.0	23.0	18.5
900	90	4.5	25.5	20.5
1000	100	4.0	28.0	22.5
1100	110	4.0	30.5	25.0
1200	120	3.5	33.0	27.0
1300	130	3.0	35.5	30.0
1400	140	3.0	38.5	32.5
1500	150	3.0	41.5	35.5
1600	160	2.5	44.5	38.5

Stationary Target: Deflector settings shown on chart.

Moving Target: Set the Horizontal deflection for the target range and then slip the scale to zero. If the target is moving from left to right the deflector setting will be "left" (L) and for a target moving from right to left the setting will be "right" (R). Elevation deflector settings shown on chart. Additional elevation settings. determined by the degree of azimuth change and direction. is given in the table below.

Azimuth Change Left	0-10		11-15		16-21	22-25
Elevation Correction	0	+	0.5	+	0.5 +	1.0
Azimuth Change Right	0-10		11-15		16-20	21-25
Elevation Correction	0		0	+	.5 +	1.0

AR 701923

Figure 2-12. Deflection table M101A1 (1 of 2)

HE CH7

R	TOF	LEAD ANGLES				
		5 m/h	10	15	20	25
400	0.9	5.0	10.0	15.0	20.0	25.0
500	1.1	5.0	10.0	14.5	20.0	24.5
600	1.3	5.0	9.5	14.5	19.5	24.0
700	1.6	5.0	10.0	15.5	20.5	25.5
800	1.8	5.0	10.0	15.0	20.0	25.0
900	2.0	5.0	10.0	15.0	20.0	25.0
1000	2.3	5.0	10.5	15.5	20.5	25.5
1100	2.5	5.0	10.0	15.0	20.5	25.5
1200	2.8	5.0	10.5	15.5	21.0	26.0
1300	3.0	5.0	10.5	15.5	20.5	25.5
1400	3.3	5.5	10.5	16.0	21.0	26.5
1500	3.6	5.5	10.5	16.0	21.5	27.0
1600	3.8	5.5	10.5	16.0	21.0	26.5

HEP-T

R	TOF	LEAD ANGLES				
		5 m/h	10	15	20	25
400	0.76	4.0	8.5	12.5	17.0	21.0
500	0.97	4.5	8.5	13.0	17.5	21.5
600	1.18	4.5	9.0	13.0	17.5	22.0
700	1.40	4.5	9.0	13.5	18.0	22.5
800	1.63	4.5	9.0	13.5	18.0	23.0
900	1.86	4.5	9.0	14.0	18.5	23.0
1000	2.10	4.5	9.5	14.0	19.0	23.5
1100	2.35	4.5	9.5	14.5	19.0	24.0
1200	2.61	5.0	9.5	14.5	19.5	24.5
1300	2.88	5.0	10.0	15.0	20.0	25.0
1400	3.15	5.0	10.0	15.0	20.0	25.0
1500	3.43	5.0	10.0	15.5	20.5	25.5
1600	3.72	5.0	10.5	15.5	21.0	26.0

AR 701924

Figure 2-12. Deflection table M101A1 (2 of 2)

2-4. **105-mm Howitzer M102.**

a. *Installation (Fig 2-13).*

(1) Install mount assembly (1) on the recuperator cylinder of the recoil mechanism three inches ±1/2 inch in front of the rear yoke, measured from the clamp jaw.

NOTE

The hand knob (2) must be on the right side of the mount with viewer facing the howitzer breech.

(2) Center the bubble ± 1/2 vial graduation in the front level vial assembly (3) attached to the mount assembly.

(3) Carefully tighten hand knob (2) and recheck the bubble.

CAUTION

Do not remove lens guard (2, fig 2-14) from laser until ready to install deflector optical assembly.

(4) Open the clamp (4, fig 2-13) on the mount (12) using the hand knob (5), and insert the laser (6) with the lens guard (2, fig 2-14) facing the muzzle of the howitzer. Key projections on the laser match the grooves in the clamp.

(5) Cross-level the laser using the gunner's quadrant M1 (weapon BII) (1, fig 2-14), placed on left side of laser six inches ± 1/2 inch from the rear. Tighten hand knob (5, fig 2-13).

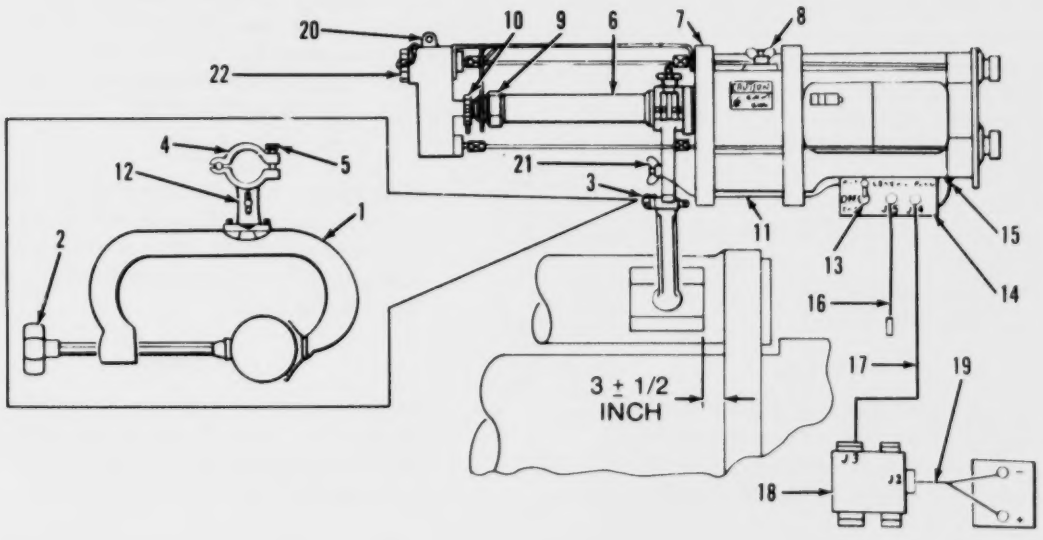
(6) Remove the lens guard (2, fig 2-14) and retain.

(7) Attach the deflector optical assembly (7, fig 2-13) to the laser; turn thumbscrew (8) until light contact is made with the laser, then back off one-half turn. Screw the adapter (9) snugly onto the end of the laser.

(8) Tighten thumbscrew (8).

(9) Level deflector optical assembly (7) using fire control level vial (20).

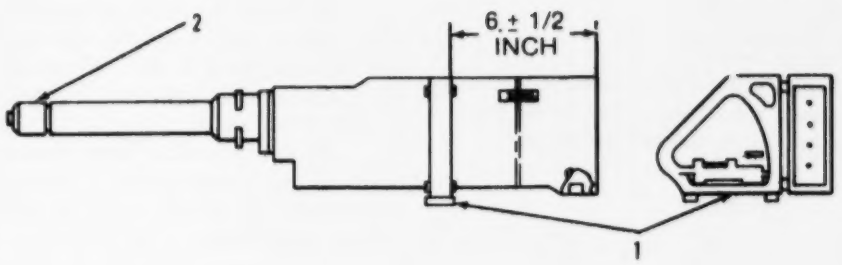
(10) Tighten ring (10) against adapter (9).



Legend for fig 2-13.

1. Mount assembly - 11747147
2. Hand knob - 11746500
3. Level vial assembly - 11736260
4. Clamp - 11746496
5. Hand knob - 11746499
6. Gunnery trainer laser M55 - 11741700
7. Deflector optical assembly - 11746410
8. Thumbscrew - 11746417
9. Adapter - 11746423
10. Ring - 11746424
11. Ground wire
12. Mount - 11746495
13. BORESIGHT OFF FIRING switch - MS24612-312K
14. Control box assembly - 11746456
15. Power cable assembly
16. LANYARD switch - 11746480
17. Cable assembly (20 ft) - 11746452
18. Distribution box - 11746450
19. Cable assembly (10 ft) - 11746454
20. Fire control level vial - 8626161
21. Wing nut - MS35425-37
22. Plug assembly - 11748075

Figure 2-13. Installation of laser and trainer on 105-mm M102 howitzer



AR 911893

Legend for fig 2-14.
1. Gunner's quadrant M1
2. Lens guard - 11741679

Figure 2-14. Alignment of laser with gunner's quadrant M1 series

(11) Align the arrow (1, fig 2-4) on the alignment indicator housing with the scribe mark (2) on the azimuth control shaft (3).

(12) Rotate elevation control shaft (6) fully counterclockwise, then rotate the elevation control shaft clockwise until the scribe mark (5) is aligned with the arrow (4).

(13) Hold the elevation knob (2, fig 2-5) and slip scale to zero. Hold the azimuth knob (1) and slip the scale to zero.

(14) Secure ground wire (11, fig 2-13) to the mount (12) with wing nut (21).

WARNING

Be sure that LASER SAFE FIRE circuit breaker (1, fig 2-6) is set to the SAFE position and BORESIGHT OFF FIRING switch (fig 2-10) is in the OFF position.

(15) Connect power cable assembly (15, fig 2-13) to receptacle 1J1 on the underside of the laser.

CAUTION

Be sure the cable of the LANYARD switch is positioned so that it will not be damaged during operation of the howitzer.

(16) Connect the LANYARD switch (16) connector to connector J5 on the control box assembly (14). Attach the lanyard switch snap just behind the knob on the weapon lanyard.

(17) Attach one cable assembly (20 ft) (17) to connector J3 on the distribution box (18) and to connector J4 on control box assembly (14).

(18) Attach cable assembly (10 ft) (19) to connector J2 on distribution box (18).

NOTE

If necessary, one cable assembly (20 ft) (17) and adapter cable assembly (8, fig 1-2) can be installed between the cable assembly (10 ft) (7) and the distribution box (18, fig 2-13).

CAUTION

Red color insulated clip goes to positive (+) terminal of the 24 vdc power supply and the black goes to the negative (-) terminal. Do not reverse polarity.

(19) Clip the cable assembly (10 ft) (19, fig 2-2) to the 24 vdc power supply.

(20) If necessary, the cable assemblies (20 ft) (fig 2-15) and the adapter cable assembly (fig 2-15) may be used to connect to the distribution box for multiple weapon operation (fig 2-15).

(21) Remove plug assembly (22, fig 2-13).

b. *Boresighting (for Training Purposes Only, See Paragraph 1-4).*

(1) Emplace the weapon so the trunnions are reasonably level (no more than 90 mils cant when measured on breech cross level plates) (1, fig 2-16).

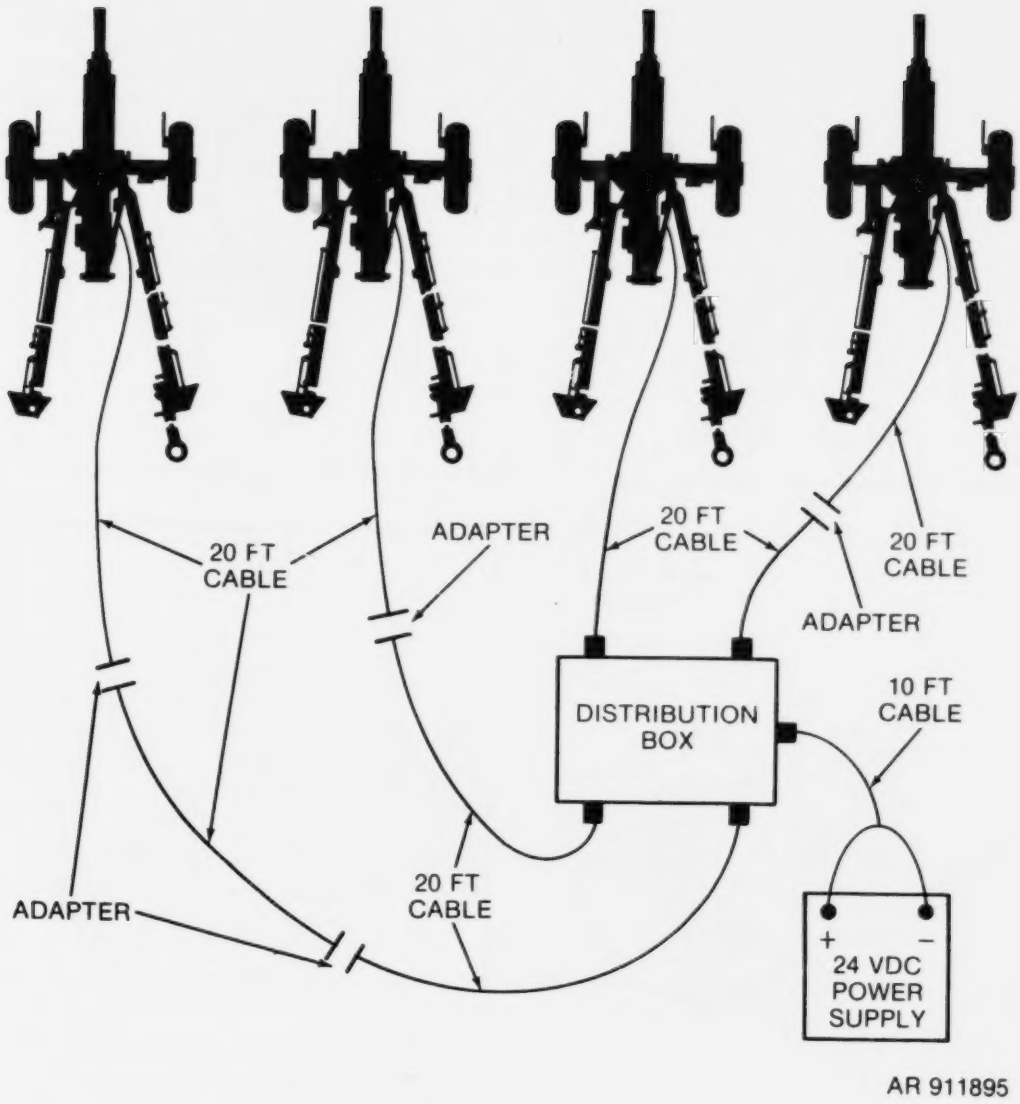
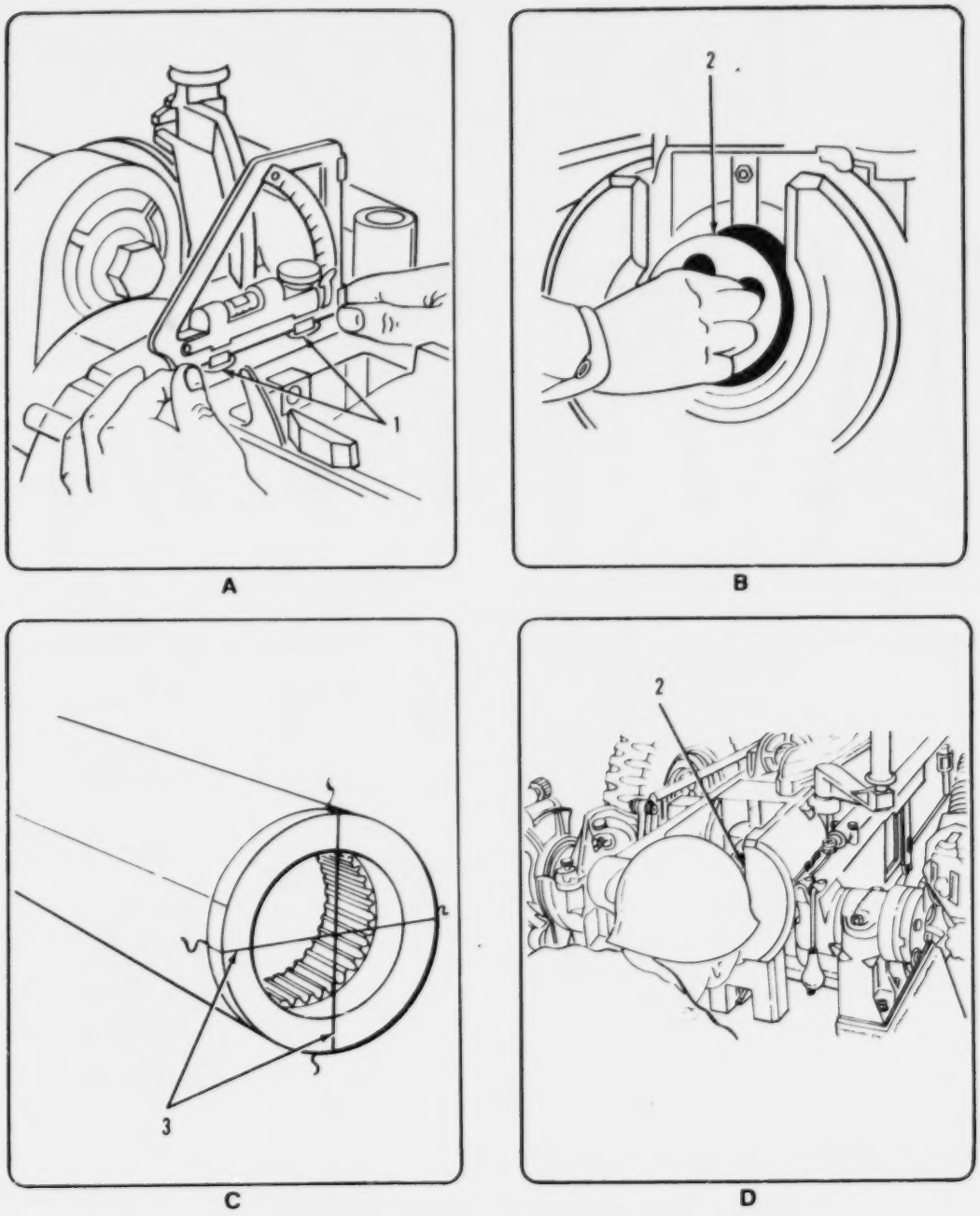


Figure 2-15. Multiple weapon operation



Legend for fig 2-16.
1. Cross level plates
2. Boresight
3. Crosshairs

Figure 2-16. Boresighting 105-mm M102 howitzer

(2) Install breech boresight (howitzer BII) (2).

(3) Fasten crosshairs (3) to muzzle.

(4) Place the trailer mounted target (fig 2-1) on level terrain and facing the cannon bore fifty meters in front of the deflector optical assembly (7, fig 2-13).

(5) Place three target assemblies (11, fig 1-2) and one target assembly (12) in their proper slots on target support assembly (1, fig 2-1).

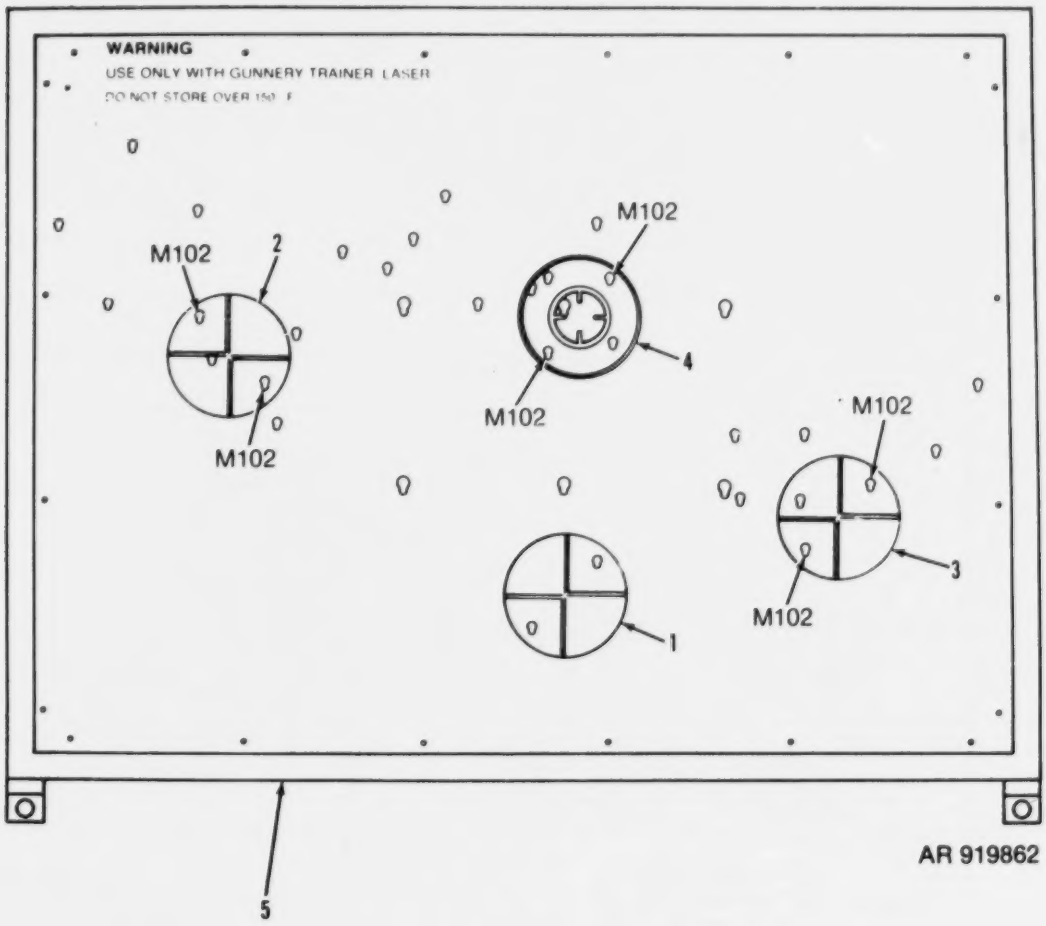
(6) Sighting through the breech boresight (2, fig 2-16) elevate and traverse the howitzer to align the muzzle crosshairs with the test target diagram on the cannon target (1, fig 2-17). If azimuth corrections are required, move trailer mounted target as necessary.

(7) Center the pitch (1, fig 2-18) and cross level bubbles (2) on the M134 telescope mount.

(8) Look through the pantel and align the reticle crosshairs (3, fig 2-18) on the test target diagram of pantel M113 target (4).

(9) The pantel azimuth counter (5, fig 2-18) should now read 3200 mils; if it does not, adjust as instructed in step 11 below.

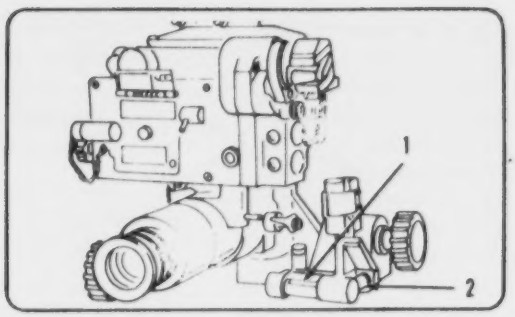
(10) Remove the boresight adjustment shaft cover (6). Depress the adjustment shaft (7) with a screwdriver and rotate until azimuth counter (5) reads 3200 mils. Replace cover.



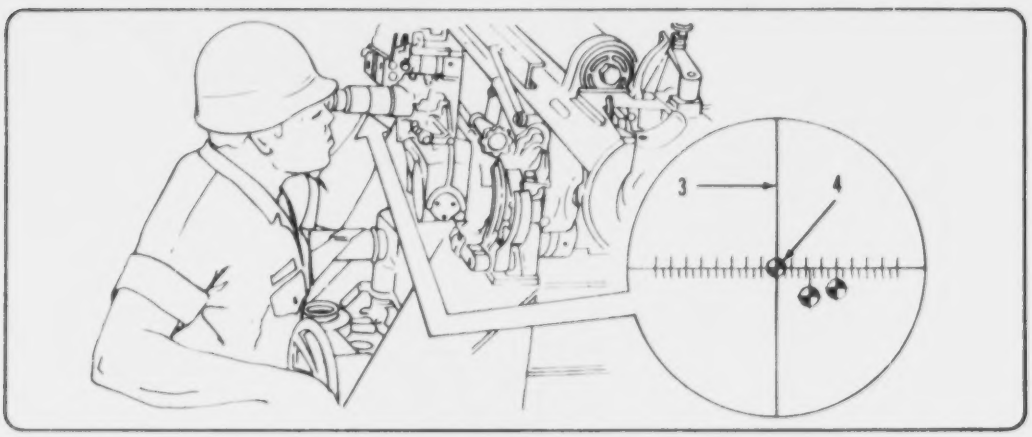
Legend for fig 2-17.

1. Cannon target - 11746461
2. M113 pantel target - 11746461
3. M114 telescope target - 11746461
4. Laser target - 11746464
5. Target support assembly

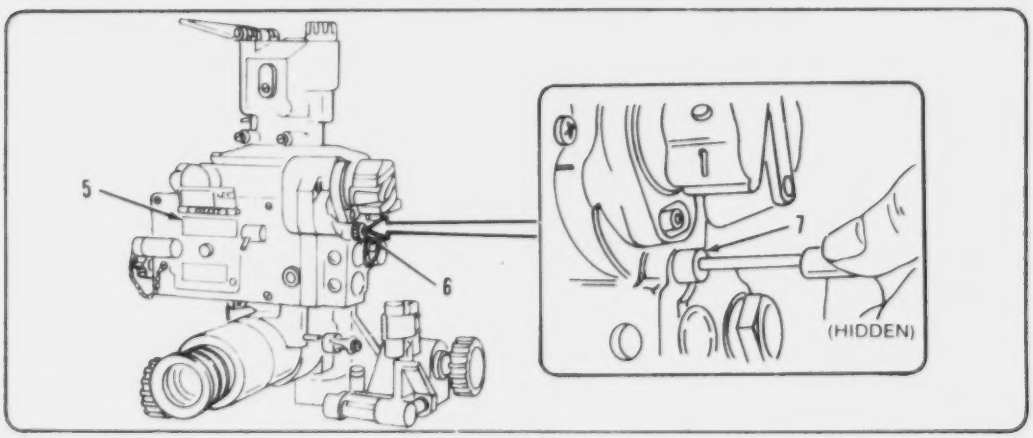
Figure 2-17. Installation of boresight targets for 105-mm M102 howitzer



A



B



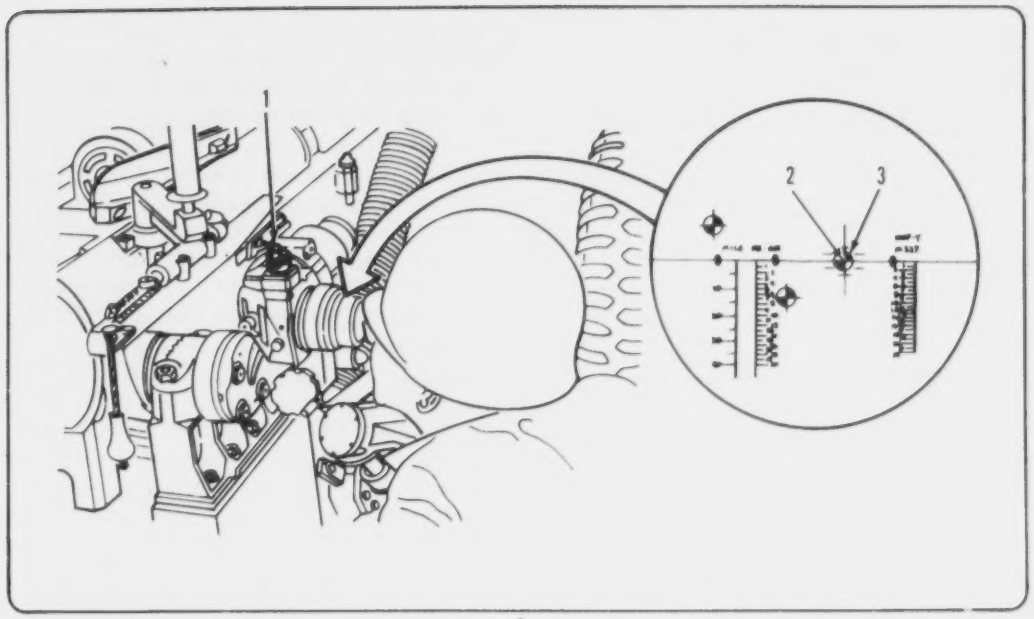
C

AR 919875

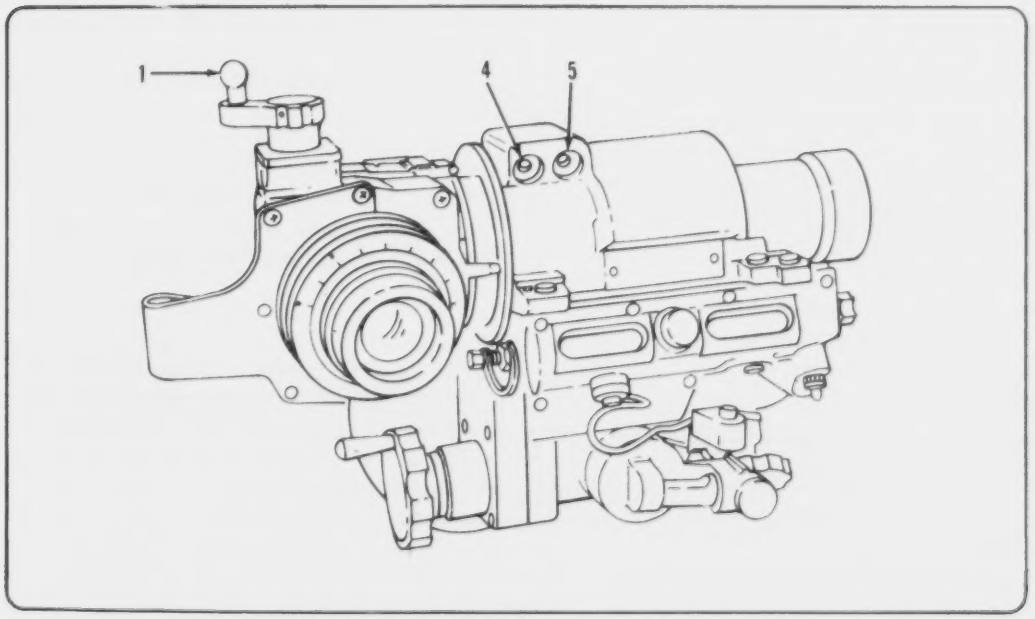
Legend for fig 2-18.

1. Pitch level vial
2. Cross level vial
3. Reticle crosshairs
4. M113 pantel target - 11746461
5. Azimuth counter
6. Boresight adjustment shaft cover
7. Adjustment shaft

Figure 2-18. Boresighting panoramic telescope M113



A



B

AR 919863

Legend for fig 2-19.

1. Range gage knob
2. Crosshairs of telescope
3. Elbow telescope M114 target - 11746461
4. Azimuth boresighting screw
5. Elevation boresighting screw

Figure 2-19. Boresighting elbow telescope M114

(11) Rotate range gage knob (1, fig 2-19) of M114 elbow telescope until range gage lines indicate zero.

(12) The direct fire telescope crosshairs (2) should now intersect with the image on the right test target diagram of the test target (3). If it does not, rotate the azimuth boresighting screw (4) and elevating boresighting screw (5) with a screwdriver until the reticle crosshairs are aligned.

WARNING

Make sure all safety precautions are taken prior to operating the laser.

NOTE

The laser requires from 30 seconds to 30 minutes to warm up.

(13) Set laser MODE CONT FLASH switch (2, fig 2-6) to CONT.

(14) Set LASER SAFE FIRE circuit breaker (1) to FIRE.

(15) Hold BORESIGHT OFF FIRING switch (fig 2-10) in BORESIGHT position as long as necessary to complete the boresight procedures.

NOTE

The laser TRIGGER ON (3, fig 2-6) and LASER ON (4) indicator lamps illuminate as long as the BORESIGHT OFF FIRING switch (fig 2-10) is held in the BORESIGHT position.

(16) Turn AZ knob (1, fig 2-5) and EL knob (2) until the laser beam is centered on target (4, fig 2-17). Slip both scales to zero.

NOTE

Check that at least 45 mils down deflection and 27 mils azimuth movement remain. If not, notify organizational maintenance.

(17) Release BORESIGHT OFF FIRING switch (fig 2-10). It is spring loaded and will return automatically.

(18) Set LASER SAFE FIRE circuit breaker (1, fig 2-6) to SAFE.

(19) Set laser MODE CONT FLASH switch (2) to FLASH.

WARNING

If the laser trainer is not to be immediately operated, the power supply should be disconnected to prevent accidental firing of the laser.

c. *Checkout Prior to Operation.*

WARNING

Before proceeding, make sure the LASER SAFE FIRE circuit breaker (1, fig 2-6) is set to SAFE and TRIGGER ON indicator lamp (3) is not illuminated.

(1) With the laser and deflector optical assembly (7, fig 2-13) installed and ready for operation, proceed as follows: LASER SAFE FIRE circuit breaker (1, fig 2-6) set to SAFE, MODE CONT FLASH switch (2) set to CONT, BORESIGHT OFF FIRING switch (fig 2-10) set to BORESIGHT and held. Observe that TRIGGER ON indicator lamp (3, fig 2-6) illuminates.

(2) Place the BORESIGHT OFF FIRING switch (fig 2-10) in FIRING position and MODE CONT FLASH switch (2, fig 2-6) in FLASH position. Pull on LANYARD switch (16, fig 2-13) and observe that TRIGGER ON indicator lamp (3, fig 2-6) illuminates.

(3) Place the LASER SAFE FIRE circuit breaker (1) in FIRE position. While observing the target, note that a shot of laser light is emitted each time that either the BORESIGHT OFF FIRING switch (fig 2-10) is pressed or LANYARD switch (16, fig 2-13) is pulled.

(4) Set the LASER SAFE FIRE circuit breaker (1, fig 2-6) to SAFE.

(5) Set the BORESIGHT OFF FIRING switch (fig 2-10) to OFF.

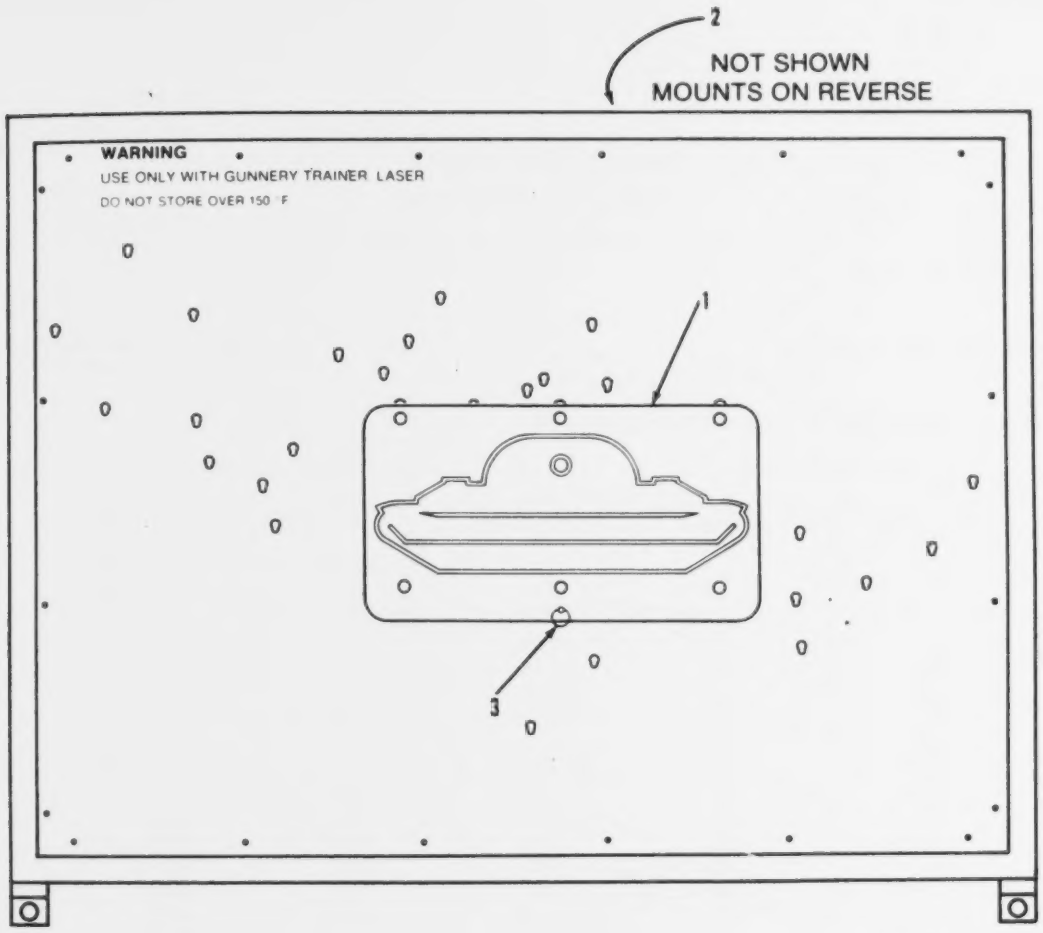
WARNING

If the laser is not to be immediately operated, the power supply should be disconnected to prevent accidental firing of the laser.

d. *Operation.*

(1) Remove all target assemblies (1,2,3,4, fig 2-17) from target support assembly (5). Mount tank silhouette targets (1,2, fig 2-20), one on each side of target board, at their designated locations on the target support assembly (5, fig 2-17) and secure with quick disconnect pin (3, fig 2-20) attached to target (1).

(2) Normal firing procedures, designated in TM 9-1015-234-12, will be followed with the instructor making all the deflector optical assembly adjustments (app D). For this training exercise the105-mm Howitzer M102 deflection table (fig 2-21) will be used for parallax correction, and for all inputs at all applicable ranges. Refer to applicable portions of the deflection table (fig 2-21 and app D) for moving target training instructions and inputs.



Legend for fig 2-20.
1. Target, moving - 11746475
2. Target, stationary (not shown) - 11746468
3. Pin - MS17987-C306

Figure 2-20. Installation of tank silhouette targets on trailer mounted target for 105-mm M102 howitzer

(3) Set the laser MODE CONT FLASH switch (2, fig 2-6) to FLASH.

(4) Set the LASER SAFE FIRE circuit breaker switch (1) to FIRE.

(5) Set the BORESIGHT OFF FIRING switch (fig 2-10) to the FIRING position. Pull the LANYARD switch (16, fig 2-13) as required by the training exercise and the laser will emit one shot of laser light visible on the retroreflective target for each pull. The laser TRIGGER ON (3, fig 2-6) and LASER ON (4) indicator lamps illuminate each time the LANYARD switch (16, fig 2-13) is pulled.

(6) After completion of exercise, set the LASER SAFE FIRE circuit breaker (1, fig 2-6) to SAFE and the BORESIGHT OFF FIRING switch (fig 2-10) to OFF.

WARNING

If the laser trainer is not to be immediately operated, the power supply should be disconnected to prevent accidental firing of the laser.

DEFLECTION TABLE
LASER TRAINER M55
(ARTILLERY APPLICATION)

105 MM HOW. M102

AMMUNITION: HE CH7
HEP-T

Mounting Location: Recoil Mechanism. Rear of Gun

RANGE IN METERS		DEFLECTOR SETTINGS		
SIMULATED	ACTUAL	HORIZONTAL	VERTICAL D	
		L	HE CH7	HEP-T
400	40	14.5	16.5	14.5
500	50	11.5	17.5	14.5
600	60	9.5	18.5	15.0
700	70	8.0	20.0	16.0
800	80	7.0	21.5	17.5
900	90	6.5	23.5	19.0
1000	100	6.0	25.5	20.5
1100	110	5.0	28.0	22.5
1200	120	5.0	30.0	24.5
1300	130	4.5	32.5	26.5
1400	140	4.0	35.0	29.0
1500	150	4.0	38.0	31.0
1600	160	3.5	40.0	34.0

Stationary Target: Deflector settings shown on chart.

Moving Target: Set the Horizontal deflection for the target range and then slip the scale to zero. If the target is moving from left to right the deflector setting will be "left" (L) and for a target moving from right to left the setting will be "right" (R). Elevation deflector settings shown on chart. Additional elevation settings. determined by the degree of azimuth change and direction. is given in the table below.

Azimuth Change Left	0-10		11-15		16-21	22-25
Elevation Correction	0	-	0.5	-	0.5 -	1.0
Azimuth Change Right	0-10		11-15		16-20	21-25
Elevation Correction	0		0	-	.5 -	1.0

AR 701925

Figure 2-21. Deflection table M102 (1 of 2)

105 MM HOW. M102

HE CH7

R	TOF	LEAD ANGLES				
		5 m/h	10	15	20	25
400	0.8	4.5	9.0	13.5	18.0	22.5
500	1.0	4.5	9.0	13.5	18.0	22.5
600	1.3	5.0	9.5	14.5	19.5	24.0
700	1.5	5.0	9.5	14.5	19.0	24.0
800	1.7	4.5	9.5	14.0	19.0	23.5
900	1.9	4.5	9.5	14.0	19.0	23.5
1000	2.2	5.0	10.0	14.5	19.5	24.5
1100	2.4	5.0	10.0	14.5	19.5	24.5
1200	2.6	5.0	9.5	14.5	19.5	24.0
1300	2.9	5.0	10.0	15.0	20.0	25.0
1400	3.1	5.0	10.0	15.0	20.0	24.5
1500	3.4	5.0	10.0	15.0	20.5	25.5
1600	3.6	5.0	10.0	15.0	20.0	25.0

HEP-T

R	TOF	LEAD ANGLES				
		5 m/h	10	15	20	25
400	0.70	4.0	8.0	11.5	15.5	19.5
500	0.89	4.0	8.0	12.0	16.0	20.0
600	1.09	4.0	8.0	12.0	16.0	20.5
700	1.29	4.0	8.0	12.5	16.5	20.5
800	1.50	4.0	8.5	12.5	17.0	21.0
900	1.71	4.0	8.5	12.5	17.0	21.0
1000	1.93	4.5	8.5	13.0	17.5	21.5
1100	2.16	4.5	9.0	13.0	17.5	22.0
1200	2.39	4.5	9.0	13.5	18.0	22.5
1300	2.63	4.5	9.0	13.5	18.0	22.5
1400	2.88	4.5	9.0	14.0	18.5	23.0
1500	3.14	4.5	9.5	14.0	18.5	23.5
1600	3.40	4.5	9.5	14.0	19.0	23.5

AR 701926

Figure 2-21. Deflection table M102 (2 of 2)

e. *Removal of Laser.*

WARNING

Make sure the LASER SAFE FIRE circuit breaker (1, fig 2-6) is set to SAFE and the BORESIGHT OFF FIRING switch (fig 2-10) is set to OFF.

(1) Install plug assembly (22, fig 2-13).

(2) Disconnect cable assembly (10 ft) (19) from power source and from distribution box (18).

(3) Disconnect cable assembly (20 ft) (17) and adapter cable assembly (8, fig 1-2), if used, from distribution box (18, fig 2-13) and control box (14).

(4) Disconnect LANYARD switch (16) from weapon lanyard and control box (14).

(5) Disconnect cable assembly (15) from 1J1 receptacle on the underside of the laser.

(6) Loosen wing nut (21) and remove ground wire (11) from mount (12).

(7) Loosen thumbscrew (8) until light contact is maintained, unlock ring (10), and unscrew adapter (9).

(8) Loosen thumbscrew (8) completely and remove deflector optical assembly (7).

(9) Install lens guard (2, fig 2-14) on laser.

(10) Loosen hand knob (5, fig 2-13), open clamp (4) (leave clamp open for storage), and remove laser (6).

(11) Loosen hand knob (2) and remove mount assembly (1).

(12) Perform after firing PMCS and pack laser and trainer in their respective carrying cases and storage containers.

2-5. **155-mm Howitzer M109 and M109A1.**

a. *Installation (Fig 2-22).*

(1) Install mount assembly (1) on the upper left recoil cylinder 13 3/4 inches ± 1/4 inch from the rear of the clamp jaw to the front of the variable recoil cover assembly.

NOTE

The hand knob (2) must be on the right side of the mount with viewer facing the howitzer breech.

(2) Center the bubble ± 1/2 vial graduation in the front level vial assembly (3) attached to the mount assembly (1).

(3) Carefully tighten hand knob (2) and recheck the bubble.

CAUTION

Do not remove lens guard (2, fig 2-23) from laser until ready to install deflector optical assembly.

(4) Open the clamp (4, fig 2-22) on the mount (12) using the hand knob (5), and insert the laser (6), with the lens guard facing the muzzle of the howitzer. Key projections on the laser match the grooves in the clamp.

(5) Cross level the laser using the gunner's quadrant M1 (weapon BII) (1, fig 2-23) placed on the left side of the laser 6 inches ± 1/2 inch from the rear. Tighten knob (5, fig 2-22).

(6) Remove the lens guard (2, fig 2-23) and retain.

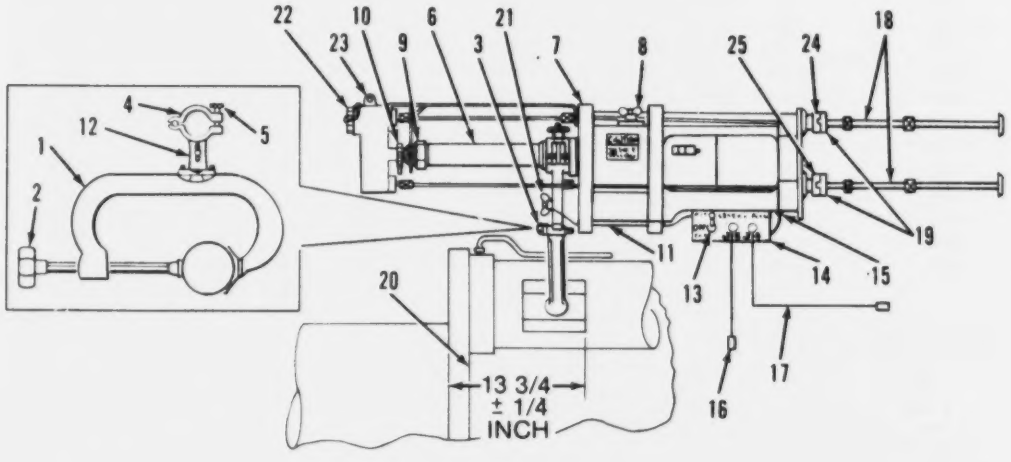
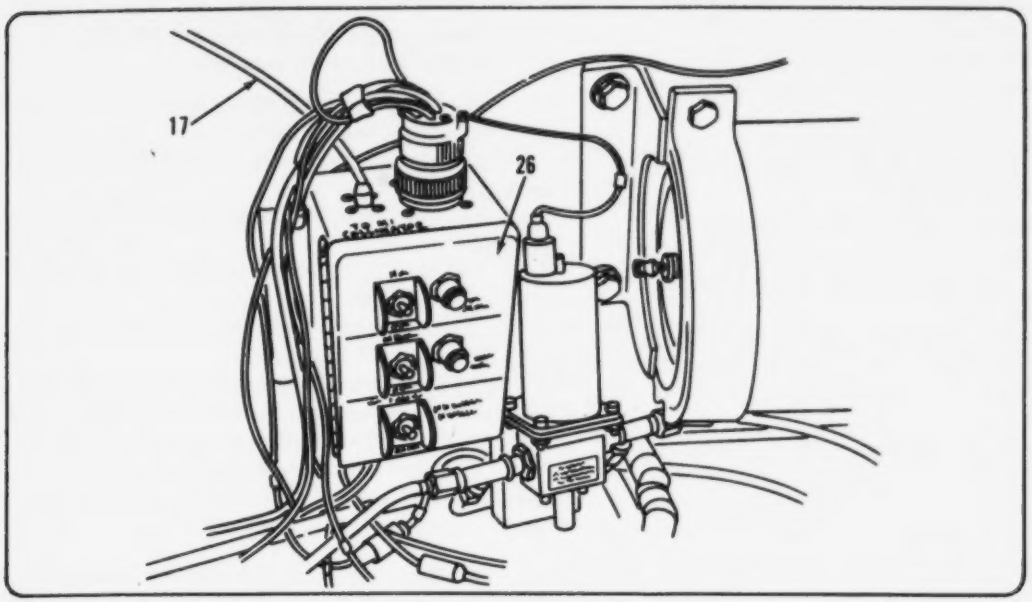


Figure 2-22. Installation of laser and trainer on 155-mm M109/M109A1 howitzer (1 of 2)



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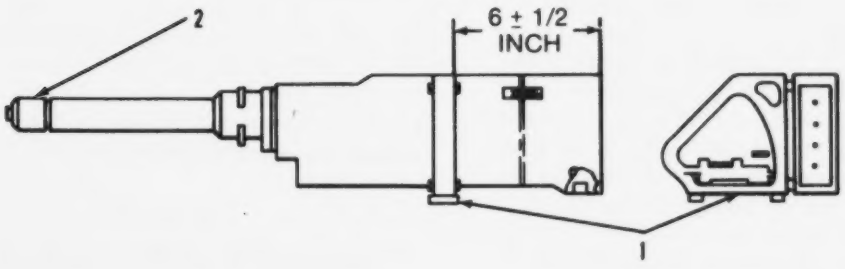
Legend for fig 2-22.

1. Mount assembly - 11747147
2. Hand knob - 11746500
3. Level vial assembly - 11736260
4. Clamp - 11746496
5. Hand knob - 11746499
6. Gunnery trainer laser M55 - 11741700
7. Deflector optical assembly - 11746410
8. Thumbscrew - 11746417
9. Adapter - 11746423
10. Ring - 11746424
11. Ground wire
12. Mount - 11746495
13. BORESIGHT OFF FIRING switch - MS24612-312K
14. Control box assembly - 11746456
15. Power cable assembly
16. LANYARD switch - 11746480
17. M109 power cable assembly - 11747170
18. Control rods (2) - 11746446
19. Control rod screws (2) (not shown)
20. Variable recoil cover - 10895694
21. Wing nut - MS35425-37
22. Plug assembly - 11748045
23. Fire control level vial - 8626161
24. Elevation knob
25. Azimuth knob
26. Cab power box

Figure 2-22. Installation of laser and trainer on 155-mm M109/M109A1 howitzer (2 of 2)



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Legend for fig 2-23.

1. Gunner's quadrant M1
2. Lens guard - 11741679

Figure 2-23. Alignment of laser with gunner's quadrant M1 series

(7) Attach the deflector optical assembly (7, fig 2-22) to the laser; turn thumbscrew (8) until light contact is made with the laser, then back off one-half turn. Screw the adapter (9) snugly onto the end of the laser.

(8) Tighten thumbscrew (8).

(9) Level deflector optical assembly (7) using fire control level vial (23).

(10) Tighten ring (10) against adapter (9).

(11) Align the arrow (1, fig 2-4) on the alignment indicator housing with the scribe mark (2) on the azimuth control shaft.

(12) Rotate elevation control shaft (6) fully counterclockwise. Rotate the elevation control shaft clockwise until the scribe mark (5) is aligned with the arrow (4).

(13) Hold the elevation knob (2, fig 2-5) and slip scale to zero. Hold the azimuth knob (1) and slip the scale to zero.

(14) Secure ground wire (11, fig 2-22) to the mount (12) with wing nut (21).

WARNING

Be sure that LASER SAFE FIRE circuit breaker (1, fig 2-6) is set to the SAFE position and BORESIGHT OFF FIRING switch (fig 2-10) is in the OFF position.

(15) Connect power cable assembly (15, fig 2-22) to receptacle 1J1 on the underside of the laser.

CAUTION

Be sure the cable of the lanyard switch is positioned so that it will not be damaged during operation of the howitzer.

(16) Connect the LANYARD switch (16) connector to connector J5 on the control box assembly (14).

(17) Extend the LANYARD switch from the control box assembly through the gunner's escape hatch. Attach the lanyard switch snap just behind the knob on the weapon lanyard.

(18) Connect M109 power cable assembly (17) to connector J4 on the control box assembly (14) and plug the other end into the collimator receptacle on the cab power box (26, fig 2-22) in the vehicle.

(19) Attach control rods (18) to the respective azimuth and elevation knobs (24 and 25, fig 2-22) of the deflector optical assembly (7) by inserting the keys into the keyways on the knobs. Tighten screws (19).

(20) Remove plug assembly (22).

b. *Boresighting (for Training Purposes Only, See Paragraph 1-4) (Fig 2-24).*

(1) Position howitzer on level ground.

(2) Open breech and install breech boresight (1, fig 2-24).

(3) Fasten crosshairs (2) to muzzle.

NOTE

Telescope M117 and telescope M118C/M118CA1 must be installed.

(4) Use pretested gunner's quadrant (M1 series) (3) to level trunnions as follows:

(a) Set index arm (4) and micrometer knob (5) to zero.

(b) Set quadrant on crosswise quadrant seats (6).

(c) Shift howitzer or build up low side until bubble centers.

(5) Center bubbles in pitch level vial and cross-level vials of M145 mount.

(6) Place the trailer mounted target (fig 2-1) on level terrain and facing the cannon bore fifty meters in front of the deflector optical assembly (7, fig 2-22).

(7) Place three target assemblies (11, fig 1-2) and one target assembly (12) in their proper slots on target support assembly (fig 2-25).

(8) Sighting through the breech boresight (1, fig 2-24) elevate and traverse the howitzer to align the muzzle crosshairs with the test target diagram on the cannon target (1, fig 2-25). If azimuth corrections are required, move the trailer mounted target as necessary.

(9) Set gunner's aid counters (7, fig 2-24), to zero on pantel (M117 series).

(10) Adjust azimuth (8) and elevation (9) knobs to lay reticle precisely on test target diagram (2, fig 2-25).

(11) Now check that muzzle crosshairs (2, fig 2-24) are still centered on center cannon test target diagram (1, fig 2-25).

(12) Check level vials (10, fig 2-24) to be sure telescope mount is level.

(13) Azimuth counter (11) should read 3200 mils. If it does not, remove cover from boresight detent shaft (12, fig 2-24), insert small screwdriver and depress detent shaft. Turn until 3200 mils appears in azimuth counter window. Recheck sight pattern to be sure telescope is still in boresight.

(14) Rotate azimuth (13) and elevation knobs (14) to lay reticle precisely on right butterfly telescope M117 series target (3, fig 2-25).

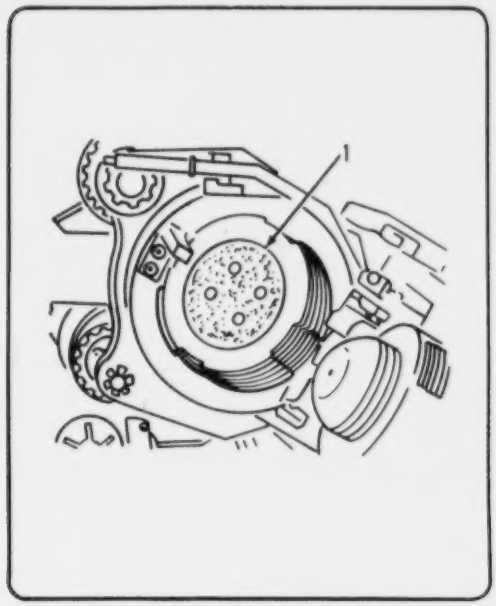
(15) Set telescope mount slip scales (15 and 16, fig 2-24) to elevation 4, azimuth 4. (Don't move azimuth and elevation knobs (14) and (13) when setting slip scales).

WARNING

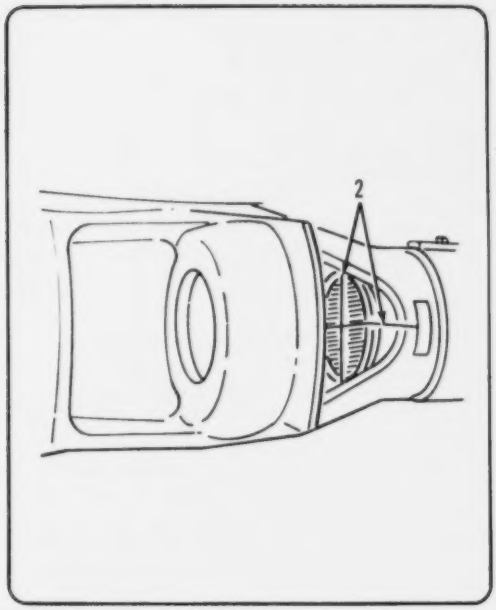
Make sure all safety precautions are taken prior to operating the laser.

NOTE

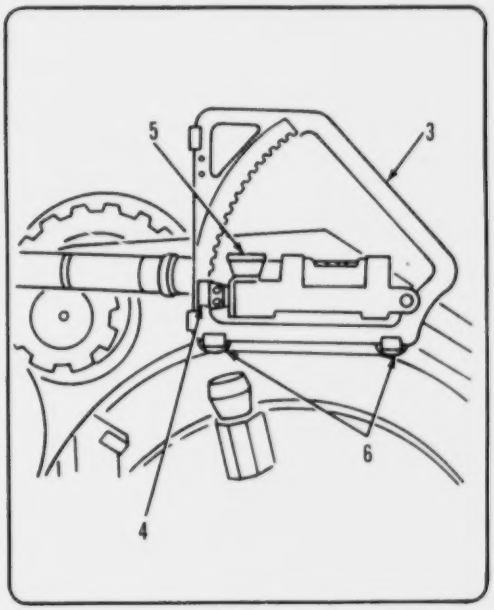
The laser requires from 30 seconds to 30 minutes to warm up.



A



B



C

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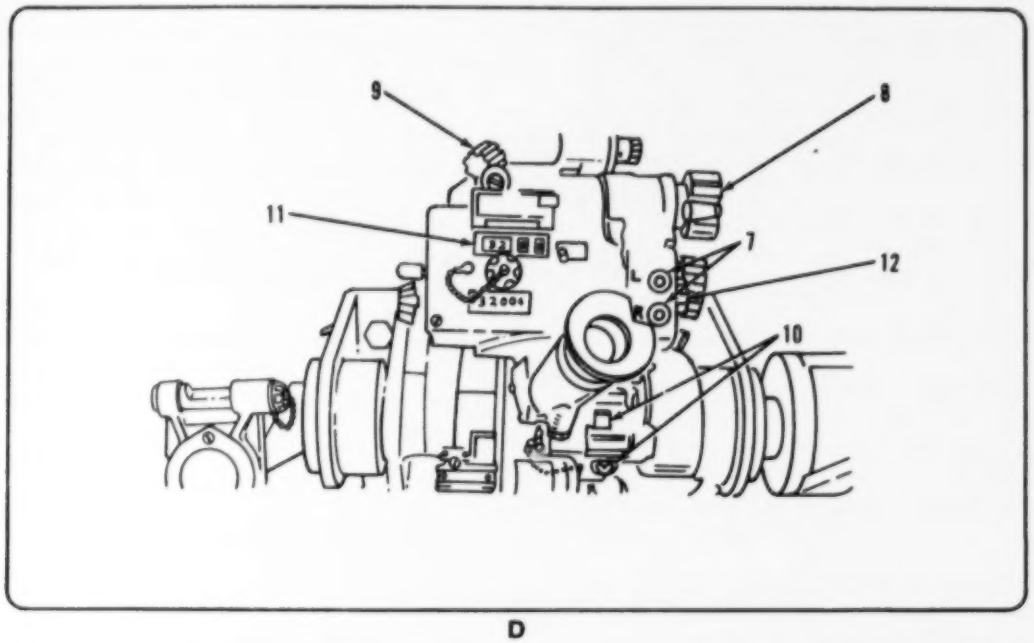
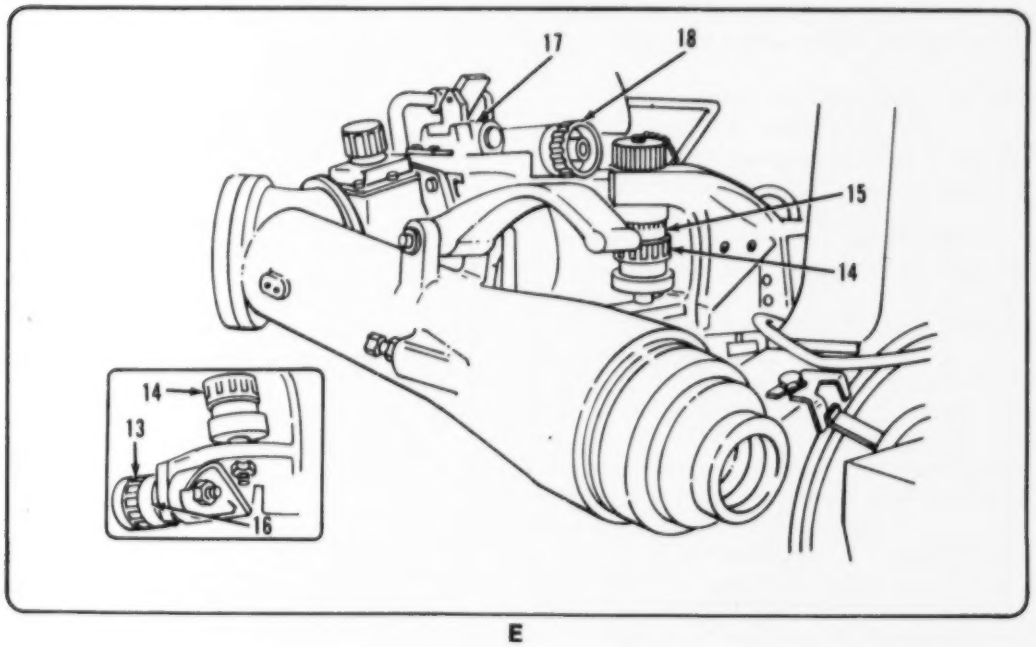
Legend for fig 2-24.

1. Breech boresight
2. Crosshairs
3. Gunner's quadrant M1 series
4. Index arm
5. Micrometer knob
6. Quadrant seats

Figure 2-24. Boresighting 155-mm M109/M109A1 howitzer (1 of 2)



D



E

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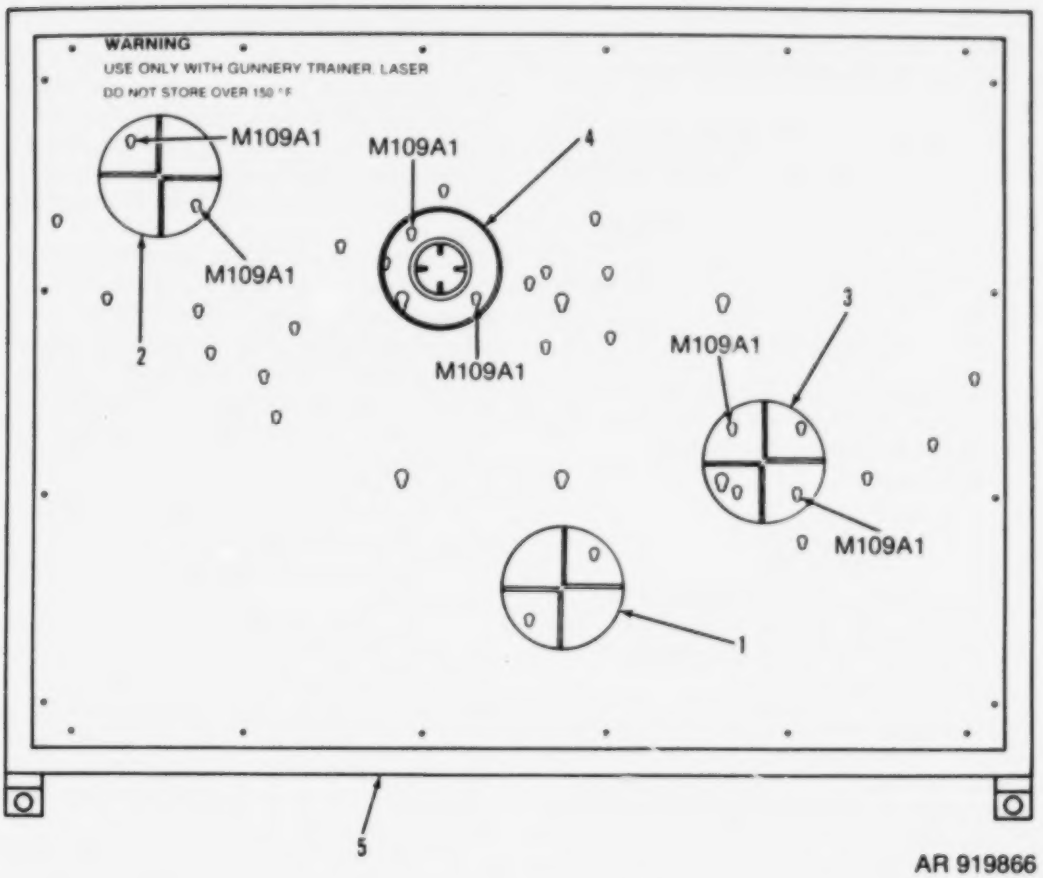
Legend for fig 2-24 - Continued.

7. Gunner's aid counters
8. Azimuth knob
9. Elevation knob
10. Level vials (not shown)
11. Azimuth counter
12. Detent shaft
13. Azimuth knob
14. Elevation knob
15. Slip scale
16. Slip scale
17. Cross leveling vial
18. Cross leveling knob

Figure 2-24. Boresighting 155-mm M109/M109A1 howitzer (2 of 2)



Legend for fig 2-25.

1. Cannon target - 11746461
2. M117 pantel target - 11746461
3. M118C telescope target - 11746461
4. Laser target - 11746464
5. Target support assembly

Figure 2-25. Installation of boresight targets for 155-mm M109/M109A1 howitzer

(16) Set laser MODE CONT FLASH switch (2, fig 2-6) to CONT.

(17) Set LASER SAFE FIRE circuit breaker (1) to FIRE.

(18) Hold BORESIGHT OFF FIRING switch (fig 2-10) in BORESIGHT position as long as necessary to complete the boresight procedures.

NOTE

The laser TRIGGER ON (3, fig 2-6) and LASER ON (4) indicator lamps illuminate as long as the BORESIGHT OFF FIRING switch (fig 2-10) is held in the BORESIGHT position.

(19) Turn AZ knob (1, fig 2-5) and EL knob (2), until the laser beam is centered on target(4, fig 2-25). Slip both scales to zero.

NOTE

Check that at least 45 mils down deflection and 27 mils azimuth movement remain. If not, notify organizational maintenance.

(20) Release BORESIGHT OFF FIRING switch (fig 2-10). It is spring loaded and will return automatically.

(21) Set laser SAFE FIRE circuit breaker (1, fig 2-6) to SAFE.

(22) Set LASER MODE CONT FLASH switch (2) to FLASH.

WARNING

If the laser trainer is not to be immediately operated, the power supply should be disconnected to prevent accidental firing of the laser.

c. *Checkout Prior to Operation.*

WARNING

Before proceeding, make sure the LASER SAFE FIRE circuit breaker (1, fig 2-6) is set to SAFE and TRIGGER ON indicator lamp (3) is not illuminated.

(1) With the laser (6, fig 2-22) and deflector optical assembly (7) installed and ready for operation, proceed as follows: LASER SAFE FIRE circuit breaker (1, fig 2-6) set to SAFE, MODE CONT FLASH switch (2) set to CONT, BORESIGHT OFF FIRING switch (fig 2-10) set to BORESIGHT and held. Observe that TRIGGER ON indicator lamp (3, fig 2-6) illuminates.

(2) Place the BORESIGHT OFF FIRING switch (fig 2-10) in FIRING position and MODE CONT FLASH switch (2, fig 2-6) in FLASH position. Pull on LANYARD switch (16, fig 2-22) and observe that TRIGGER ON indicator lamp (3, fig 2-6) illuminates.

(3) Place the LASER SAFE FIRE circuit breaker (1) in FIRE position. While observing the target, note that a shot of laser light is emitted each time that either the BORESIGHT OFF FIRING switch (fig 2-10) is pressed or LANYARD switch (16, fig 2-22) is pulled.

(4) Set the LASER SAFE FIRE circuit breaker (1, fig 2-6) to SAFE.

(5) Set the BORESIGHT OFF FIRING switch (fig 2-10) to OFF.

WARNING

If the laser trainer is not to be immediately operated, the power supply should be disconnected to prevent accidental firing of the laser.

d. *Operation.*

(1) Remove all target assemblies (1,2,3,4, fig 2-25) from target support assembly (5). Mount required tank silhouette targets (1,2, fig 2-26), one on each side of target board, at their designated location on the target support assembly (5, fig 2-25) and secure with quick disconnect pin (3, fig 2-26) attached to target (1).

(2) Normal firing procedures, designated in TM 9-2350-217-10N, will be followed with the instructor making all the deflector optical assembly adjustments (app D). For this training exercise the 155-mm Howitzer M109 and M109A1 deflection table (fig 2-27 and 2-28) will be used for parallax correction, and for all inputs at all applicable ranges. Refer to applicable portions of the deflection table for moving target training instructions and inputs.

(3) Set the laser MODE CONT FLASH switch (2, fig 2-6) to FLASH.

(4) Set the LASER SAFE FIRE circuit breaker (1) to FIRE.

(5) Set the BORESIGHT OFF FIRING switch, (fig 2-10) to the FIRING position. Pull the LANYARD switch (16, fig 2-22) as required for the training exercise and the laser will emit one shot of laser light visible on the retroreflective target for each pull. The laser TRIGGER ON (3, fig 2-6) and LASER ON (4) indicator lamps illuminate each time the LANYARD switch (16, fig 2-22) is pulled.

(6) After completion of exercise, set the LASER SAFE FIRE circuit breaker (1, fig 2-6) to SAFE and the BORESIGHT OFF FIRING switch (fig 2-10) to OFF.

e. *Removal of Laser (Fig 2-22).*

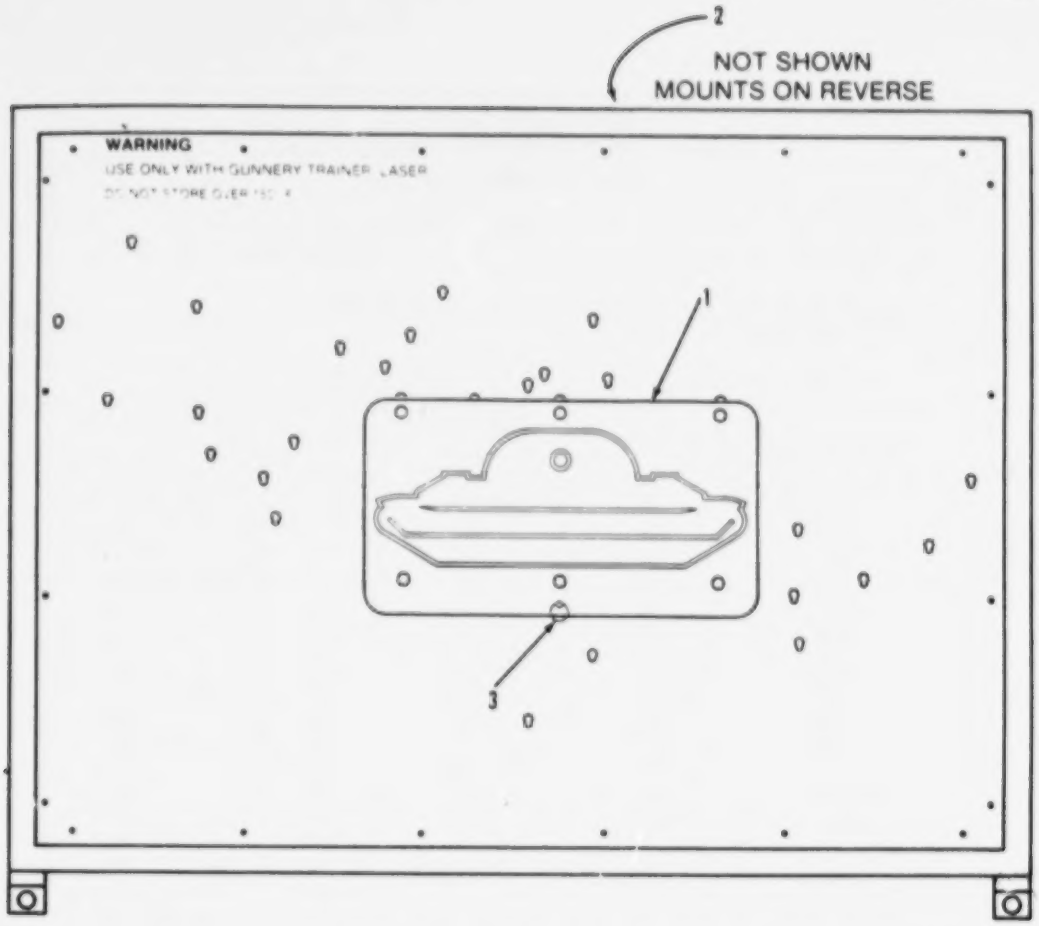
WARNING

Make sure the LASER SAFE FIRE circuit breaker (1, fig 2-6) is set to SAFE and the BORESIGHT OFF FIRING switch (fig 2-10) is set to OFF.

(1) Install plug assembly (22, fig 2-22).

(2) Disconnect M109 power cable assembly (17) from collimator receptacle on the cab power control box (19, fig 2-24) and remove from connector J4 on the control box (14, fig 2-22).

(3) Remove control rods (18) from the azimuth and elevation knobs.



Legend for fig 2-26.
1. Target, moving - 11746475
2. Target, stationary (not shown) - 11746468
3. Pin - MS17987-C306

Figure 2-26. Installation of tank silhouette targets on trailer mounted target for 155-mm M109/M109A1 howitzer

(4) Remove LANYARD switch (16) from the weapon lanyard knob. Pass this end through the gunner's escape hatch and disconnect LANYARD switch (16) from control box (14).

(5) Disconnect cable assembly (15) from 1J1 receptacle on the underside of the laser.

(6) Loosen wing nut (21) and remove ground wire (11) from mount (12).

(7) Loosen thumbscrew (8) until light contact is maintained, unlock ring (10), and unscrew adapter (9).

(8) Loosen thumbscrew (8) completely and remove deflector optical assembly (7).

(9) Install lens guard (2, fig 2-23).

(10) Loosen hand knob (5, fig 2-22), open clamp (4) (leave clamp open for storage), and remove laser.

(11) Loosen hand knob (2) and remove mount assembly (1).

(12) Perform after firing PMCS and pack laser and trainer in their respective carrying cases and storage containers.

DEFLECTION TABLE
TRAINER, FIELD ARTILLERY: DIRECT FIRE
(LASER)

155 MM HOW., M109 AMMUNITION: HE CH7

MOUNTING LOCATION: RECOIL MECHANISM, REAR OF GUN

RANGE IN METERS		DEFLECTOR SETTINGS	
SIMULATED	ACTUAL	HORIZONTAL L	VERTICAL D HE CH7
400	40	11.5	14.5
500	50	9.0	14.5
600	60	7.5	15.0
700	70	6.5	16.0
800	80	6.0	17.5
900	90	5.0	18.5
1000	100	4.5	20.0
1100	110	4.0	21.5
1200	120	4.0	23.0
1300	130	3.5	24.5
1400	140	3.5	26.5
1500	150	3.0	28.0
1600	160	3.0	30.0

STATIONARY TARGET: DEFLECTOR SETTINGS SHOWN ON CHART.

MOVING TARGET: SET THE HORIZONTAL DEFLECTION FOR THE TARGET RANGE AND THEN SLIP THE SCALE TO ZERO. IF THE TARGET IS MOVING FROM LEFT TO RIGHT THE DEFLECTOR SETTING WILL BE LEFT (L) AND FOR A TARGET MOVING FROM RIGHT TO LEFT THE SETTING WILL BE RIGHT (R). ELEVATION DEFLECTOR SETTINGS SHOWN ON CHART. ADDITIONAL ELEVATION SETTINGS, DETERMINED BY THE DEGREE OF AZIMUTH CHANGE AND DIRECTION, IS GIVEN IN THE TABLE BELOW.

AZIMUTH CHANGE LEFT	0 - 10	11 - 15	16 - 21	22 - 25
ADD TO ELEV DEFLECTION SETTING	0	+ 0.5	+ 0.5	+ 1.0

AZIMUTH CHANGE RIGHT	0 - 10	11 - 15	16 - 20	21 - 25
ADD TO ELEV DEFLECTION SETTING	0	0	+ .5	+ 1.0

PART NO. 11747164

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Figure 2-27. Deflection table M109

DEFLECTION TABLE
LASER TRAINER M55
(ARTILLERY KIT)

155 MM HOW. M109A1

AMMUNITION: HE CH7
HE CH8

Mounting Location: Recoil Mechanism, Rear of Gun

RANGE IN METERS		DEFLECTOR SETTINGS		
SIMULATED	ACTUAL	HORIZONTAL	VERTICAL D	
		L	HE CH7	HE CH8
400	40	11.5	14.0	12.0
500	50	9.0	14.0	11.5
600	60	7.5	15.0	11.5
700	70	6.5	16.0	12.0
800	80	6.0	17.0	12.5
900	90	5.0	18.0	13.5
1000	100	4.5	19.5	14.0
1100	110	4.0	21.0	15.0
1200	120	4.0	22.5	16.0
1300	130	3.5	24.0	17.0
1400	140	3.5	25.5	18.0
1500	150	3.0	27.5	19.0
1600	160	3.0	29.0	20.5

Stationary Target: Deflector settings shown on chart.

Moving Target: Set the Horizontal deflection for the target range and then slip the scale to zero. If the target is moving from left to right the deflector setting will be "left" (L) and for a target moving from right to left the setting will be "right" (R). Elevation deflector settings shown on chart. Additional elevation settings, determined by the degree of azimuth change and direction, is given in the table below.

Azimuth Change Left	0-10		11-15		16-21	22-25
Elevation Correction	0	+	0.5	+	0.5 +	1.0
Azimuth Change Right	0-10		11-15		16-20	21-25
Elevation Correction	0		0	+	.5 +	1.0

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Figure 2-28. Deflection table M109A1 (1 of 2)

HE CH7

R	TOF	LEAD ANGLES				
		5 m/h	10	15	20	25
400	0.7	4.0	8.0	12.0	15.5	19.5
500	0.9	4.0	8.0	12.0	16.0	20.0
600	1.1	4.0	8.0	12.5	16.5	20.5
700	1.3	4.0	8.5	12.5	16.5	20.5
800	1.5	4.0	8.5	12.5	17.0	21.0
900	1.7	4.0	8.5	12.5	17.0	21.0
1000	1.8	4.0	8.0	12.0	16.0	20.0
1100	2.0	4.0	8.0	12.0	16.5	20.5
1200	2.2	4.0	8.0	12.5	16.5	20.5
1300	2.4	4.0	8.5	12.5	16.5	20.5
1400	2.6	4.0	8.5	12.5	16.5	20.5
1500	2.8	4.0	8.5	12.5	16.5	21.0
1600	3.0	4.0	8.5	12.5	17.0	21.0

HE CH8

R	TOF	LEAD ANGLES				
		5 m/h	10	15	20	25
400	0.6	3.5	6.5	10.0	13.5	17.0
500	0.7	3.0	6.0	9.5	12.5	15.5
600	0.9	3.5	6.5	10.0	13.5	17.0
700	1.1	3.5	7.0	10.5	14.0	17.5
800	1.2	3.5	6.5	10.0	13.5	17.0
900	1.4	3.5	7.0	10.5	14.0	17.5
1000	1.5	3.5	6.5	10.0	13.5	17.0
1100	1.7	3.5	7.0	10.5	14.0	17.5
1200	1.8	3.5	6.5	10.0	13.5	17.0
1300	2.0	3.5	7.0	10.5	14.0	17.0
1400	2.2	3.5	7.0	10.5	14.0	17.5
1500	2.3	3.5	7.0	10.5	13.5	17.0
1600	2.5	3.5	7.0	10.5	14.0	17.5

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Figure 2-28. Deflection table M109A1 (2 of 2)

2-6. **155-mm Howitzer M114A1 and M114A2.**

a. *Installation (Fig 2-29).*

(1) Remove mount (6, fig 1-2) from the mount assembly (5, fig 1-2) and retain mounting hardware.

(2) Mount the adapter assembly (1, fig 2-29) on the howitzer using tapped holes in the recoil mechanism (2).

NOTE

The adapter assembly will be positioned with the short leg of the adapter towards the breech of the howitzer.

(3) Install mount (3) on adapter assembly and secure with hardware removed in (1) above.

NOTE

Hand knob (4) must be on the left when viewer is facing breech end of howitzer.

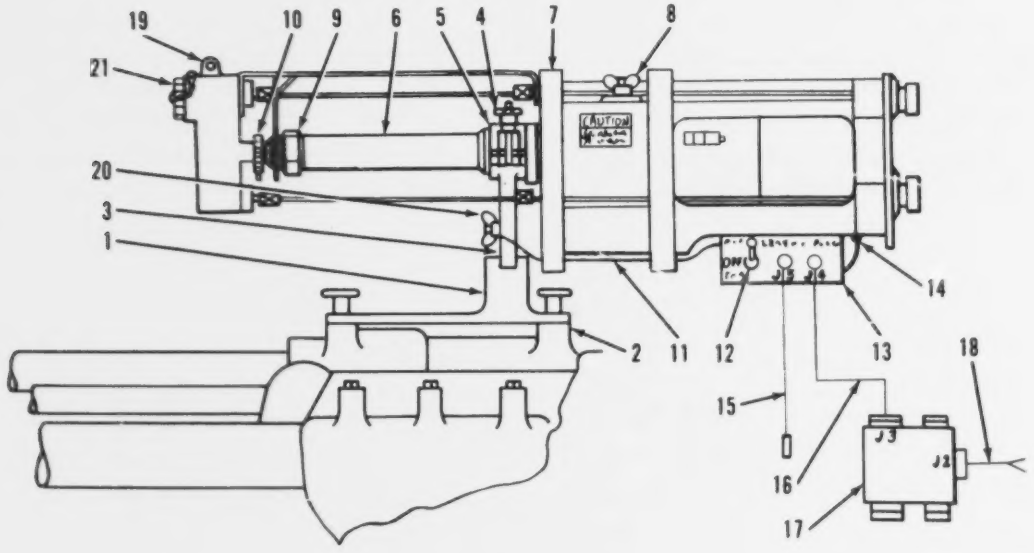
CAUTION

Do not remove lens guard (2, fig 2-30) from laser until ready to install deflector optical assembly.

(4) Open the clamp (5, fig 2-29) on the mount (3) using the hand knob (4), and insert the laser (6), with the lens guard facing the muzzle of the howitzer. Key projections on the laser match the grooves in the clamp.

(5) Cross level the laser using the gunner's quadrant M1 series (weapon BII) (1, fig 2-30) placed on left side of laser 6 inches ± 1/2 inch from rear. Tighten knob (4, fig 2-29).

(6) Remove the lens guard (2, fig 2-30) and retain.



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Legend for fig 2-29.

1. M114A1 adapter assembly - 11747146
2. Recoil mechanism
3. Mount - 11746495
4. Hand knob - 11746499
5. Clamp - 11746496
6. Gunnery trainer laser M55 - 11741700
7. Deflector optical assembly - 11746410
8. Thumbscrew - 11746417
9. Adapter - 11746423
10. Ring - 11746424
11. Ground wire
12. BORESIGHT OFF FIRING switch - MS24612-312K
13. Control box assembly - 11746456
14. Power cable assembly
15. LANYARD switch - 11746480
16. Cable assembly (20 ft) - 11746452
17. Distribution box - 11746450
18. Cable assembly (10 ft) - 11746454
19. Level vial - 11736260
20. Wing nut - MS35425-37
21. Plug assembly - 11748015

Figure 2-29. Installation of laser and trainer on 155-mm M114A1/M114A2 howitzer

(7) Attach the deflector optical assembly (7, fig 2-29) to the laser; turn thumbscrew (8) until light contact is made with the laser, then back off one half turn. Screw the adapter (9) snugly onto the end of the laser.

(8) Tighten thumbscrew (8).

(9) Level deflector optical assembly (7) using fire control level vial (19).

(10) Tighten ring (10) against adapter (9).

(11) Align the arrow (1, fig 2-4) on the alignment indicator housing with the scribe mark (2) on the azimuth control shaft (3).

(12) Rotate elevation control shaft (6) fully counterclockwise, then rotate the elevation control shaft clockwise until the scribe mark (5) is aligned with the arrow (4).

(13) Hold the elevation knob (2, fig 2-5) and slip scale to zero. Hold the azimuth knob (1) and slip the scale to zero.

(14) Secure ground wire (11, fig 2-29) to the mount (3) with wing nut (20).

WARNING

Be sure that LASER SAFE FIRE circuit breaker (1, fig 2-6) is set to the SAFE position and BORESIGHT OFF FIRING switch (fig 2-10) is in the OFF position.

(15) Connect cable assembly (14, fig 2-29) to terminal 1J1 on the underside of the laser.

CAUTION

Be sure the cable of the LANYARD switch (15) is positioned so that it will not be damaged during operation of the howitzer.

(16) Connect the LANYARD switch (15) connector to connector J5 on the control box assembly (13). Attach the lanyard switch snap just behind the knob on the weapon lanyard.

(17) Attach one cable assembly (20 ft) (16) to connector J3 on the distribution box (17) and to connector J4 on control box assembly (13).

(18) Attach cable assembly (10 ft) (18) to connector J2 on distribution box (17).

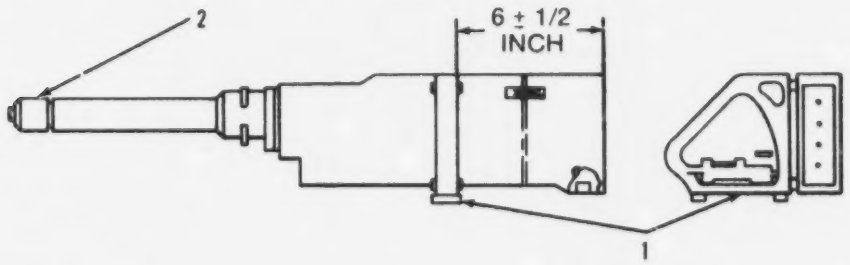
NOTE

If necessary, one cable assembly (20 ft) (16) and adapter cable assembly (8, fig 1-2) can be installed between the cable assembly (10 ft) (18, fig 2-29) and the distribution box.

CAUTION

Red color insulated clip goes to positive (+) terminal of the 24 vdc power supply and the black goes to the negative (-) terminal. Do not reverse polarity.

(19) Clip the cable assembly (10 ft) (18) to the 24 vdc power supply.



Legend for fig 2-30.

1. Gunner's quadrant M1
2. Lens guard - 11741679

Figure 2-30. Alignment of laser with gunner's quadrant M1 series

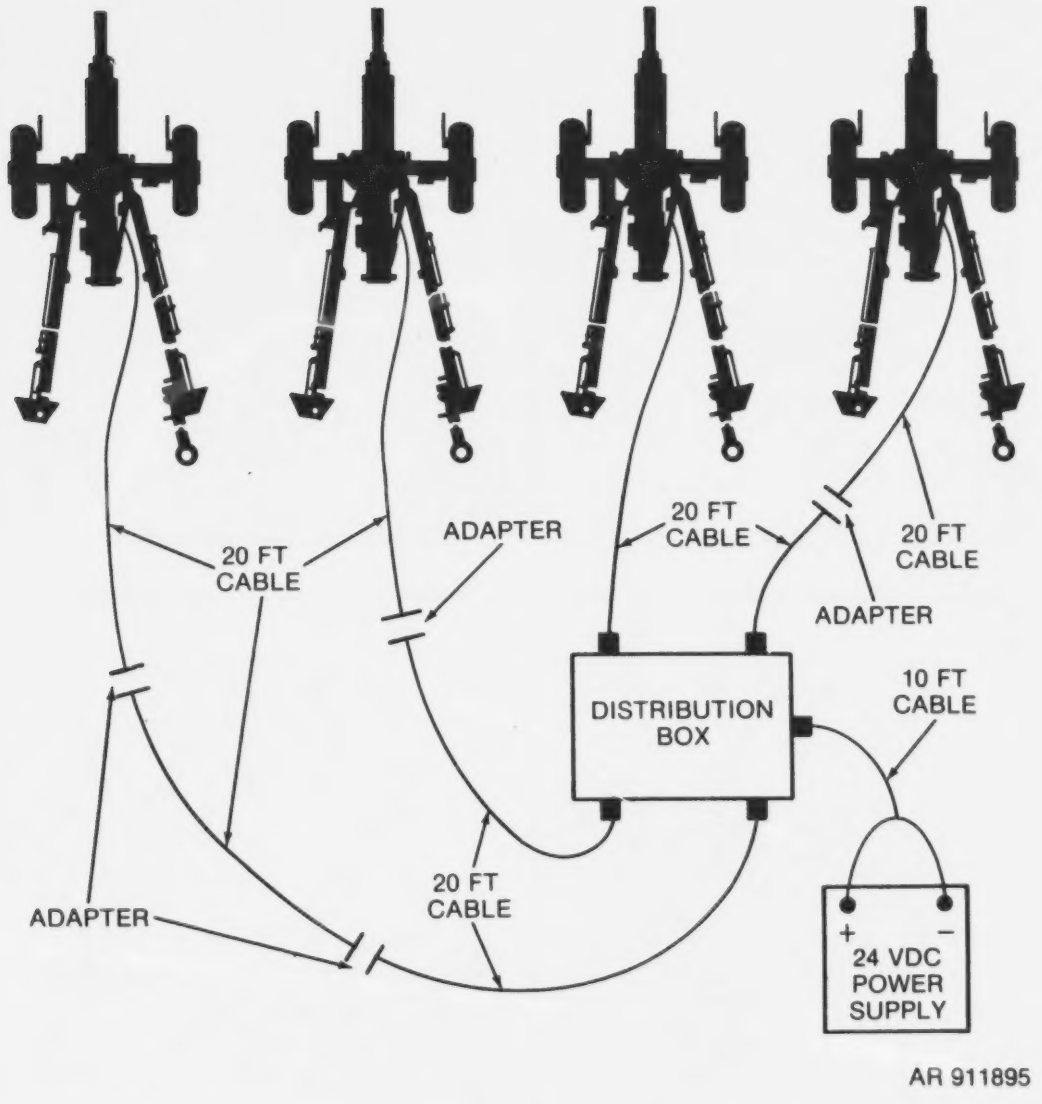


Figure 2-31. Multiple weapon operation

(20) If necessary, the cable assemblies (20 ft) and the adapter cable assembly (8, fig 1-2) may be used to connect to the distribution box (2) for multiple weapon operation (fig 2-31).

(21) Remove plug assembly (21, fig 2-29).

b. *Boresighting (for Training Purposes Only, See Paragraph 1-4) (Fig 2-32).*

(1) Place howitzer on level ground.

(2) Position cannon tube in center of traverse.

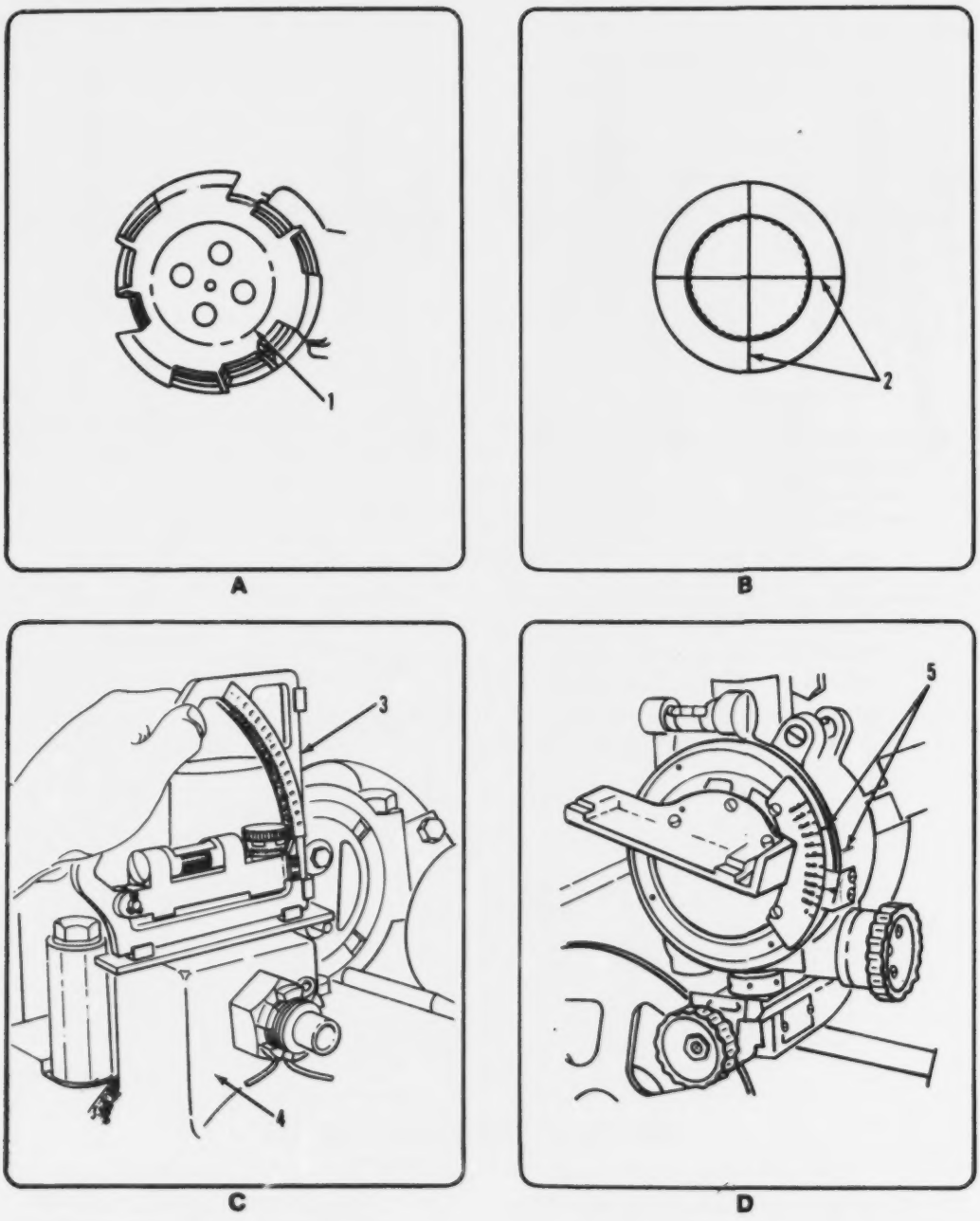
(3) Install breech boresight (howitzer BII) (1, fig 2-32).

(4) Fasten crosshairs (2) to muzzle.

(5) Measure cant of trunnions by placing gunner's quadrant M1 series (3) traversely across the counterrecoil piston rod lug (4) on the breech ring. The trunnions must be level at 0 mils elevation.

(6) Align the scribe marks (5) on the telescope mount M25.

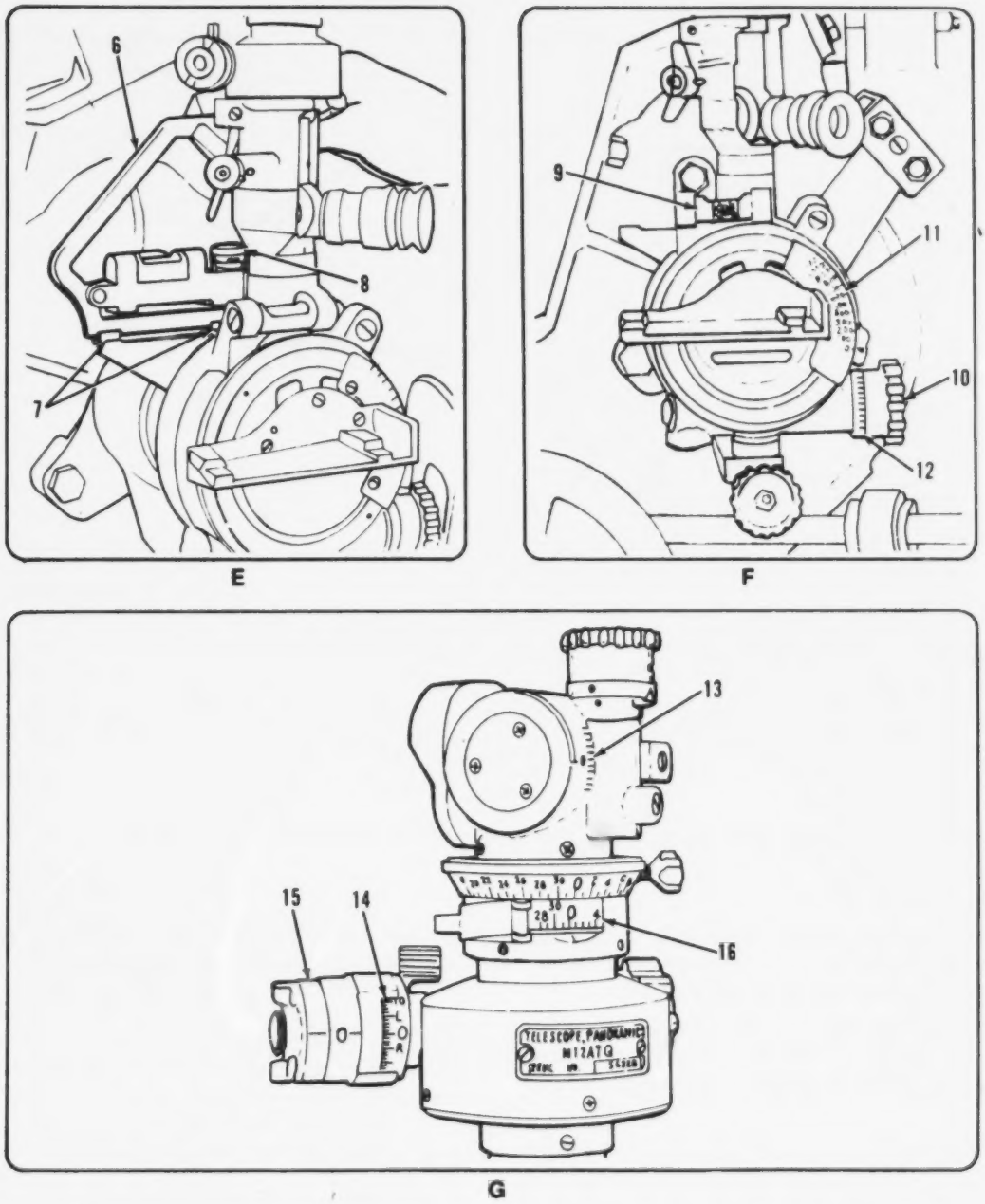
(7) Place the trailer mounted target (fig 2-1) on level terrain and facing the cannon bore fifty meters in front of the deflector optical assembly (7, fig 2-36).



Legend for fig 2-32.

1. Boresight
2. Crosshairs
3. Gunner's quadrant M1 series
4. Counterrecoil piston rod lug
5. Scribe marks

Figure 2-32. Boresighting 155-mm M114A1/M114A2 howitzer (1 of 3)



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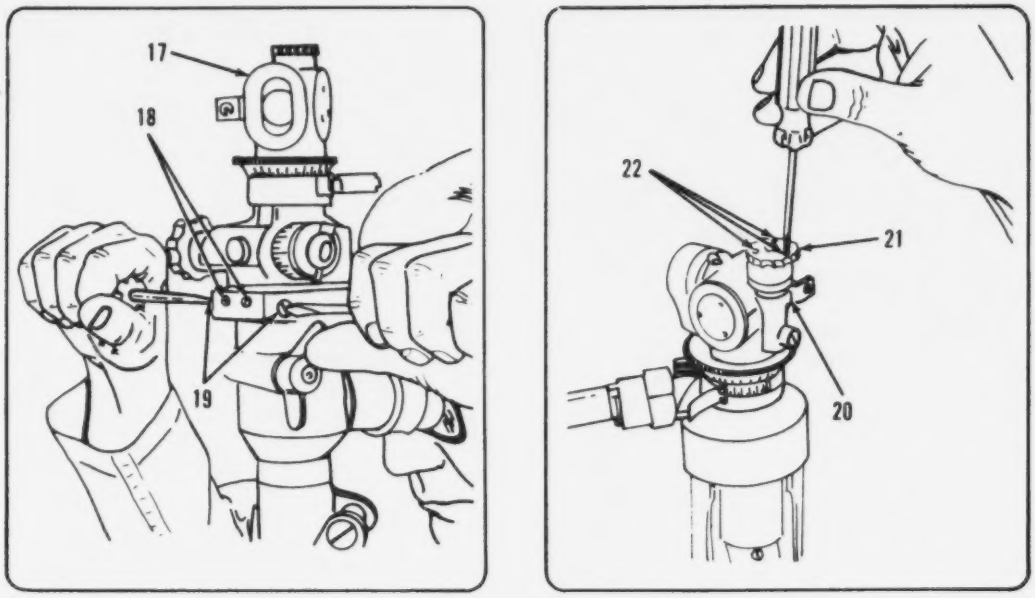
Legend for fig 2-32 - Continued

6. Gunner's quadrant M1 series
7. Quadrant seats
8. Micrometer knob
9. Elevation bubble
10. Elevation knob
11. Elevation scale
12. Micrometer scale
13. Elevation indexes
14. Deflection correcting scale
15. Micrometer index scale
16. Slipping azimuth scale

Figure 2-32. Boresighting 155-mm M114A1/M114A2 howitzer (2 of 3)



Legend for fig 2-32 - Continued.

17. Pantel
18. Locking screws
19. Tangent screws
20. Elevation indexes
21. Screws
22. Elevation knob

Figure 2-32. Boresighting 155-mm M114A1/M114A2 howitzer (3 of 3)

(8) Place two target assemblies (1,2, fig 2-33) and one target assembly (3) in their proper slots on the target support assembly (4, fig 2-33).

(9) Sighting through the breech boresight, elevate and traverse the howitzer to align the muzzle crosshairs with the test target diagram on the cannon target (1).

(10) Place the gunner's quadrant (6, fig 2-32) on the actuating arm quadrant seats (7). Center the bubble using the micrometer knob (8). If the final reading is within +0.5 mil of initial reading go to step (12). If the difference between final and initial readings is greater than +0.5 mil but less than +1.0 mil, adjust the actuating arm bracket before going to step (12). If difference is greater than +1.0 mil, perform a fire control alignment test.

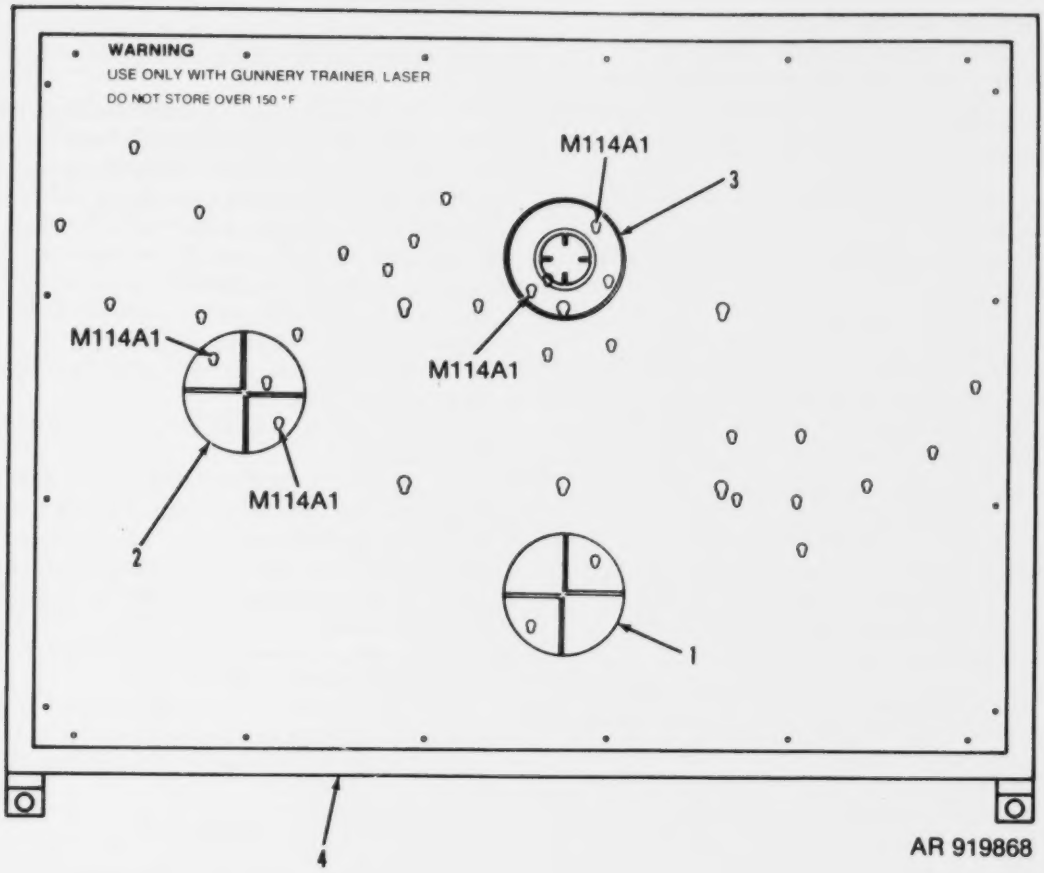
(11) Without moving the tube, level the elevation bubble (9) using the mount elevation knob (10). When the elevation bubble (9) centers, the elevation scale (11) and the micrometer scale (12) should read 0 within ±1.0 mil. If the error is greater than ±1.0 mil but less than ±2.0 mils, adjust the scales to read 0 before going to step (12). If error is greater than ±2.0 mils, perform a fire control alignment test.

(12) Align the coarse and fine elevation indexes (13), zero the deflection correcting scale (14), azimuth micrometer index scale (15), and slipping azimuth scale (16).

(13) If the vertical reticle line of the pantel (17) is off, correct by loosening the tangent locking screws (18) and adjusting the tangent screws (19). Tighten tangent locking screws (18) and check for proper alignment of vertical hairline.

(14) If the horizontal reticle line is not aligned, the elevation knob (10) must be adjusted. Turn the elevation knob (10) until the horizontal reticle line is properly aligned.

(15) Check to see if the elevation indexes (20) are aligned. If not, loosen three screws (21) and turn the elevation knob (22) until indexes are aligned. Then tighten the three screws (21). After adjustments have been made, ensure you still have the proper sight picture.



Legend for fig 2-33.
1. Cannon target - 11746461
2. M7A12 pantel target - 11746461
3. Laser target - 11746464
4. Target support assembly

Figure 2-33. Installation of boresight targets for 155-mm M114A1/M114A2 howitzer

WARNING

Make sure all safety precautions are taken prior to operating the laser.

NOTE

The laser requires from thirty seconds to thirty minutes to warm up.

(16) Set laser MODE CONT FLASH switch (2, fig 2-6) to CONT.

(17) Set LASER SAFE FIRE circuit breaker (1) to FIRE.

(18) Hold BORESIGHT OFF FIRING switch (fig 2-10) in BORESIGHT position as long as necessary to complete the boresight procedures.

NOTE

The laser TRIGGER ON (3, fig 2-6) and LASER ON (4) indicator lamps illuminate as long as the BORESIGHT OFF FIRING switch (fig 2-10) is held in the BORESIGHT position.

(19) Turn AZ knob (1, fig 2-5) and EL knob (2) until the laser beam is centered on target (3, fig 2-33). Slip both scales to zero.

NOTE

Check that at least 45 mils down deflection and 27 mils azimuth movement remain. If not, notify organizational maintenance.

(20) Release BORESIGHT OFF FIRING switch (fig 2-10). It is spring loaded and will return automatically.

(21) Set LASER SAFE FIRE circuit breaker (1, fig 2-6) to SAFE.

(22) Set laser MODE CONT FLASH switch (2) to FLASH.

WARNING

If the laser trainer is not to be immediately operated, the power supply should be disconnected to prevent accidental firing of the laser.

c. *Checkout Prior to Operation.*

WARNING

Before proceeding, make sure the LASER SAFE FIRE circuit breaker (1, fig 2-6) is set to SAFE and TRIGGER ON indicator lamp (3) is not illuminated.

(1) With the laser (6, fig 2-29) and deflector optical assembly (7) installed and ready for operation, proceed as follows: LASER SAFE FIRE circuit breaker (1, fig 2-6) set to SAFE, MODE CONT FLASH switch (2) set to CONT, BORESIGHT OFF FIRING switch (fig 2-10) set to BORESIGHT and held. Observe that TRIGGER ON indicator lamp (3, fig 2-6) illuminates.

(2) Place the BORESIGHT OFF FIRING switch (fig 2-10) in FIRING position and MODE CONT FLASH switch (2, fig 2-6) in FLASH position. Pull on LANYARD switch (15, fig 2-29) and observe that TRIGGER ON (3, fig 2-6) indicator lamp illuminates.

(3) Place the LASER SAFE FIRE circuit breaker (1) in FIRE position. While observing the target, note that a shot of laser light is emitted each time that either the BORESIGHT OFF FIRING switch (fig 2-10) is pressed or LANYARD switch (15, fig 2-29) is pulled.

(4) Set the LASER SAFE FIRE circuit breaker (1, fig 2-6) to SAFE.

(5) Set the BORESIGHT OFF FIRING switch (fig 2-10) to the OFF position.

WARNING

If the laser trainer is not to be immediately operated, the power supply should be disconnected to prevent accidental firing of the laser.

d. *Operation.*

(1) Remove all target assemblies (1, 2, 3, fig 2-33) from target support assembly (4). Mount tank silhouette targets (1, 2, fig 2-34), one on each side of target support assembly (4, fig 2-33), at their designated location on the target board and secure with quick disconnect pin (3, fig 2-34) attached to target (1).

(2) Normal firing procedures, designated in TM 9-1025-200-12, will be followed with the instructor making all the deflector assembly adjustments (app D). For this training exercise the 155-mm Howitzer M114A1 deflection table (fig 2-35) will be used for parallax correction, and for all inputs at all applicable ranges. Refer to applicable portions of the deflection table (fig 2-35) and to appendix D for moving target training instructions and inputs.

(3) Set the laser MODE CONT FLASH switch (2, fig 2-6) to FLASH.

(4) Set the LASER SAFE FIRE circuit breaker (1) to FIRE.

(5) Set the BORESIGHT OFF FIRING switch (fig 2-10) to the FIRING position. Pull the LANYARD switch (15, fig 2-29) as required by the training exercise and the laser will emit one shot of laser light visible on the retroreflective target for each pull. The laser TRIGGER ON (3, fig 2-6) and LASER ON (4) indicator lamps illuminate each time the LANYARD switch (15, fig 2-29) is pulled.

(6) After completion of exercise, set the LASER SAFE FIRE circuit breaker switch (1, fig 2-6) to SAFE and the BORESIGHT OFF FIRING switch (fig 2-10) to OFF.

WARNING

If the laser is not to be immediately operated, the power supply should be disconnected to prevent accidental firing of the laser.

e. *Removal of Laser.*

WARNING

Make sure the LASER SAFE FIRE circuit breaker switch (1, fig 2-6) is set to SAFE and the BORESIGHT OFF FIRING switch (fig 2-10) is set to OFF.

(1) Install plug assembly (21, fig 2-29).

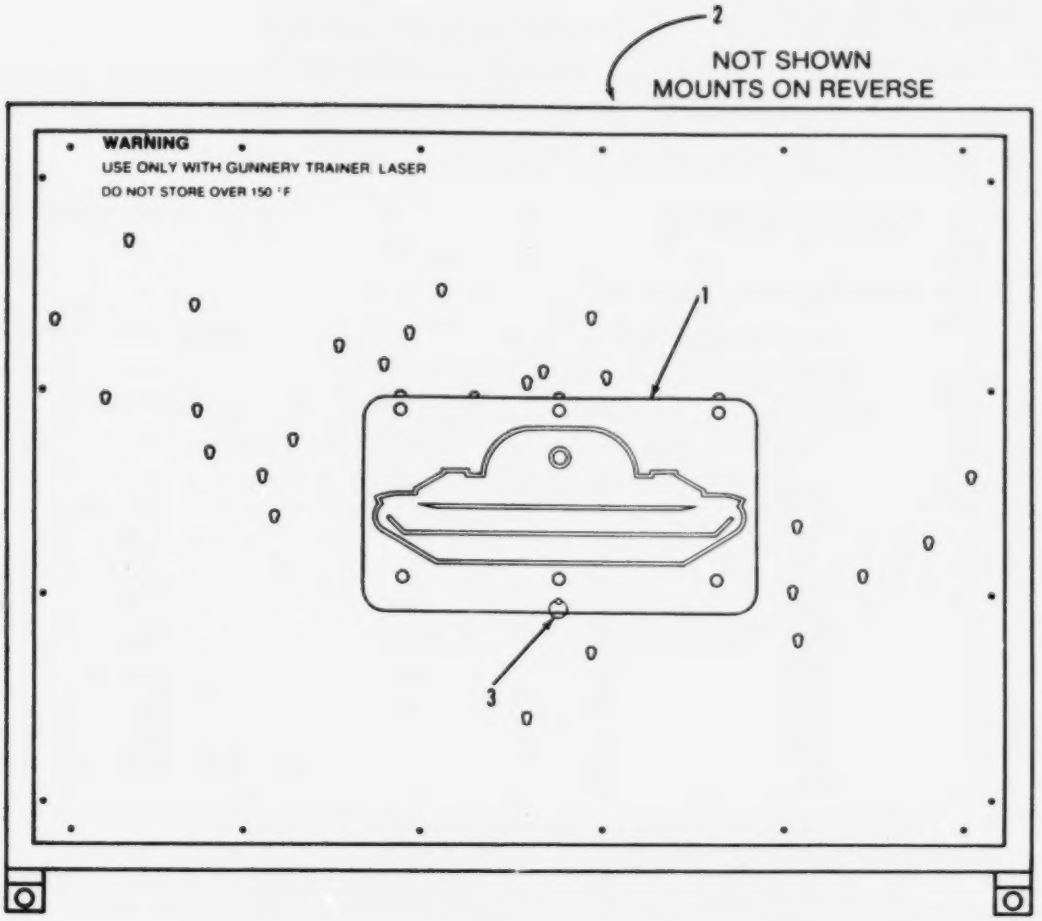
(2) Disconnect cable assembly (10 ft) (18) from power source and from distribution box (17).

(3) Remove cable assembly (20 ft) (16) and adapter cable assembly (8, fig 1-2), if used, from distribution box (17, fig 2-29) and control box (13).

(4) Disconnect LANYARD switch (15) from weapon lanyard and control box (13).

(5) Disconnect cable assembly (14) from 1J1 receptacle on the underside of the laser (6).

(6) Loosen wing nut (20) and remove ground wire (11) from mount (3).



Legend for fig 2-34.
1. Target, moving - 11746475
2. Target, stationary (not shown) - 11746468
3. Pin - MS17987-C306

Figure 2-34. Installation of tank silhouette targets on trailer mounted target for 155-mm M114A1/M114A2 howitzer

(7) Loosen thumbscrew (8) until light contact is maintained, unlock ring (10), unscrew adapter (9).

(8) Loosen thumbscrew (8) completely and remove deflector optical assembly (7).

(9) Install lens guard (2, fig 2-30).

(10) Loosen hand knob (4, fig 2-29), open clamp (5) (leave clamp open for storage), and remove laser (6).

(11) Remove mount (3) and retain mounting hardware.

(12) Install mount (3) on mount assembly (5, fig 1-2) and secure with hardware removed in (11) above.

(13) Remove adapter assembly (1, fig 2-29).

(14) Perform after firing PMCS and pack laser and trainer in their respective carrying cases and storage containers.

DEFLECTION TABLE
LASER TRAINER M55
(ARTILLERY APPLICATION)

155 MM HOW. M114A1 **AMMUNITION: HE CH7**

Mounting Location: Stuffing Box

RANGE IN METERS		DEFLECTOR SETTINGS	
SIMULATED	ACTUAL	HORIZONTAL	VERTICAL D
400	40	13.0	20.5
500	50	10.5	19.5
600	60	9.0	19.0
700	70	7.5	19.5
800	80	6.5	20.0
900	90	6.0	21.0
1000	100	5.5	22.5
1100	110	5.0	23.5
1200	120	4.5	25.0
1300	130	4.0	26.5
1400	140	4.0	28.0
1500	150	3.5	29.5
1600	160	3.5	31.0

Stationary Target: Deflector settings shown on chart.

Moving Target: Set the Horizontal deflection for the target range and then slip the scale to zero. If the target is moving from left to right the deflector setting will be "left" (L) and for a target moving from right to left the setting will be "right" (R). Elevation deflector settings shown on chart. Additional elevation settings, determined by the degree of azimuth change and direction, is given in the table below.

Azimuth Change Left	**0-10**		**11-15**		**16-21**		**22-25**
Elevation Correction	**0**	+	**0.5**	+	**0.5**	+	**1.0**
Azimuth Change Right	**0-10**		**11-15**		**16-20**		**21-25**
Elevation Correction	**0**		**0**	+	**.5**	+	**1.0**

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Figure 2-35. Deflection table M114A1/M114A2 (1 of 2)

155 MM HOW. M114A1

HE CH7

R	TOF	LEAD ANGLES				
		5 m/h	10	15	20	25
400	0.7	4.0	8.0	12.0	15.5	19.5
500	0.9	4.0	8.0	12.0	16.0	20.0
600	1.1	4.0	8.0	12.5	16.5	20.0
700	1.3	4.0	8.0	12.5	16.5	20.5
800	1.5	4.0	8.5	12.5	17.0	21.0
900	1.7	4.0	8.5	12.5	17.0	21.0
1000	1.9	4.0	8.5	12.5	17.0	21.0
1100	2.0	4.0	9.0	12.0	16.5	20.5
1200	2.2	4.0	8.0	12.5	16.5	20.5
1300	2.4	4.0	8.0	12.5	16.5	20.5
1400	2.6	4.0	8.5	12.5	16.5	20.5
1500	2.8	4.0	8.5	12.5	16.5	21.0
1600	3.0	4.0	8.5	12.5	17.0	21.0

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Figure 2-35. Deflection table M114A1/M114A2 (2 of 2)

2-7. 155-mm Howitzer M198.

a. *Installation.*

(1) Install mount assembly (1, fig 2-36) on recuperator cylinder of the recoil mechanism of the howitzer. Locate mount 13 3/4 inches ± 1/4 inch from the rear of the front yoke to the front of the clamp jaw.

NOTE

The hand knob (2) must be on the right hand side of the mount with the viewer facing the breech of the howitzer.

(2) Center the bubble of the rear vial assembly (20 degree offset) attached to the mount assembly (1).

(3) Carefully tighten hand knob (2) and recheck the bubble.

CAUTION

Do not remove lens guard (2, fig 2-37) until ready to install deflector optical assembly (7, fig 2-36).

(4) Open the clamp (4) on the mount (12) using the hand knob (5), and insert the laser (6), with the lens guard facing the muzzle of the howitzer. Projections on the laser match the grooves in the clamp.

(5) Cross level the laser using the gunner's quadrant M1 (weapon BII) (1, fig 2-37) placed on left side of laser 6 inches ± 1/2 inch from rear. Tighten knob (5, fig 2-36).

(6) Remove the lens guard (2, fig 2-37) and retain.

(7) Attach the deflector optical assembly (7, fig 2-36) to the laser; turn thumbscrew (8) until light contact is made with the laser, then back off one-half turn. Screw the adapter (9) snugly onto the end of the laser.

(8) Tighten thumbscrew (8).

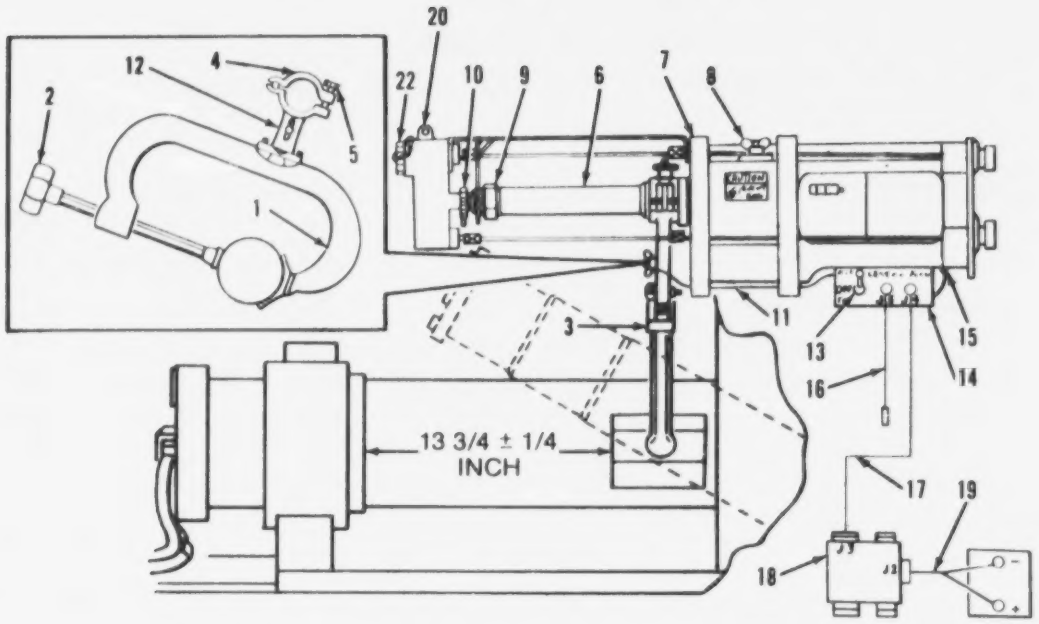
(9) Level deflector optical assembly (7) using fire control level vial (20).

(10) Tighten ring (10) against adapter (9).

(11) Align the arrow (4, fig 2-4) on the alignment indicator housing with the scribe mark (5) on the elevation control shaft (6).

(12) Rotate elevation control shaft (6) fully counterclockwise then rotate clockwise until scribe mark is aligned with arrow.

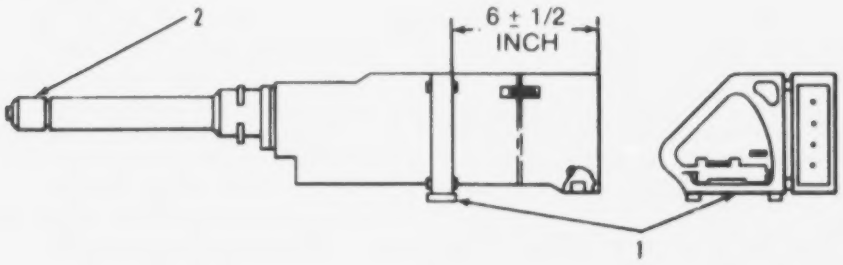
(13) Hold elevation knob (2, fig 2-5) and slip the scale to zero. Hold azimuth knob (1) and slip scale to zero.



Legend for fig 2-36.

1. Mount assembly - 11747147
2. Hand knob - 11746500
3. Level vial assembly - 11736260
4. Clamp - 11746496
5. Hand knob - 11746499
6. Gunnery trainer laser M55 - 11741700
7. Deflector optical assembly - 11746410
8. Thumbscrew - 11746417
9. Adapter - 11746423
10. Ring - 11746424
11. Ground wire
12. Mount - 11746495
13. BORESIGHT OFF FIRING switch - MS24612-312K
14. Control box assembly - 11746456
15. Power cable assembly
16. LANYARD switch - 11746480
17. Cable assembly (20 ft) - 11746452
18. Distribution box - 11746450
19. Cable assembly (10 ft) - 11746454
20. Fire control level vial
21. Wing nut
22. Plug assembly - 11748075

Figure 2-36. Installation of laser and trainer on 155-mm M198 howitzer



Legend for fig 2-37.

1. Gunner's quadrant M1
2. Lens guard - 11741679

Figure 2-37. Alignment of laser with gunner's quadrant M1 series

(14) Secure ground wire (11, fig 2-36) to the mount (12) with wing nut (21).

WARNING

Be sure that LASER FIRE SAFE circuit breaker (1, fig 2-6) is set to SAFE position and BORESIGHT OFF FIRING switch (fig 2-10) is in the OFF position.

(15) Connect cable assembly (15, fig 2-36) to receptacle on the underside of the laser.

CAUTION

Be sure the cable of the LANYARD switch (16) is positioned so that it will not be damaged during operation of the howitzer.

(16) Connect the LANYARD switch (16) connector to connector J5 on the control box assembly (14). Attach the lanyard switch snap just behind the knob on the weapon lanyard.

(17) Attach one cable assembly (20 ft) (17) to connector J3 on the distribution box (18) and to connector J4 on control box assembly (14).

(18) Attach cable assembly (10 ft) to connector J2 on distribution box (18).

NOTE

If necessary one cable assembly (20 ft) (17) and adapter cable assembly (8, fig 1-2) can be installed between the cable assembly (10 ft) and the distribution box (18, fig 2-36).

CAUTION

Red color insulated clip goes to the positive (+) terminal of the 24 vdc power supply and the black goes to the negative (-) terminal. Do not reverse polarity.

(19) Clip the cable assembly (10 ft) (7, fig 1-2) to the 24 vdc power supply.

(20) If necessary, the cable assemblies (20 ft) (21) and the adapter cable assembly (8) may be used to connect to the distribution box (2) for multiple weapon operation (fig 2-38).

(21) Remove plug assembly (22, fig 2-36).

b. *Boresighting (for Training Purposes Only, See Paragraph 1-4) (Fig 2-39).*

NOTE

It is not necessary to dig in the spades.

(2) Place pretested gunner's quadrant M1 series on the cross-leveling plates.

(3) Using a mechanical jack, jack up the howitzer (or whichever side is required) until the bubble centers in the M1 series gunner's quadrant. Leave jack in place until boresighting is completed.

(4) Place the trailer mounted target (fig 2-1) on level terrain and facing the cannon bore, fifty meters in front of the deflector optical assembly (7, fig 2-36).

(5) Place three target assemblies (1,2,3, fig 2-40) and one target assembly (4) in their proper slots on target support assembly (5).

(6) Slide block assembly (1, fig 2-39) to the open position.

(7) Fasten crosshairs (2) to muzzle.

(8) Sighting through the center hole of the breech, elevate and traverse the cannon until the crosshairs are aligned with the test target diagram of the cannon target (1, fig 2-40).

(9) Sight through the elbow telescope (3, fig 2-39) and make certain that the elevation line and azimuth line is on the test target diagram of the M138 telescope target (2, fig 2-40).

(10) If the elevation line is not aligned adjust screw (4, fig 2-39) until it is aligned.

NOTE

If an azimuth correction is required notify organizational maintenance.

(11) Level mount M171 (11) by rotating the mount pitch and cross level knobs (5) until the pitch and cross level vials (6) center.

(12) Lift the door that covers the azimuth counter (7) of the M137 pantel. Rotate the azimuth knob (8) until a 3200 mil reading is obtained on the azimuth counter.

(13) Sight through the panoramic telescope (9). The pantel crosshairs should align with the test target diagram of the M137 pantel target (3, fig 2-40). If not adjust elevation knob (10, fig 2-39), until the elevation crosshair is aligned.

(14) If the azimuth line does not align with the vertical line of the test target diagram of the target at 3200 ± 0.5 mil, notify organizational maintenance.

WARNING

Make sure all safety precautions are taken prior to operating the laser.

NOTE

The laser requires from thirty seconds to thirty minutes to warm up.

(15) Set laser MODE CONT FLASH switch (2, fig 2-6) to CONT.

(16) Set LASER SAFE FIRE circuit breaker (1) to FIRE.

(17) Hold BORESIGHT OFF FIRING switch (fig 2-10) in BORESIGHT position as long as necessary to complete the boresight procedures.

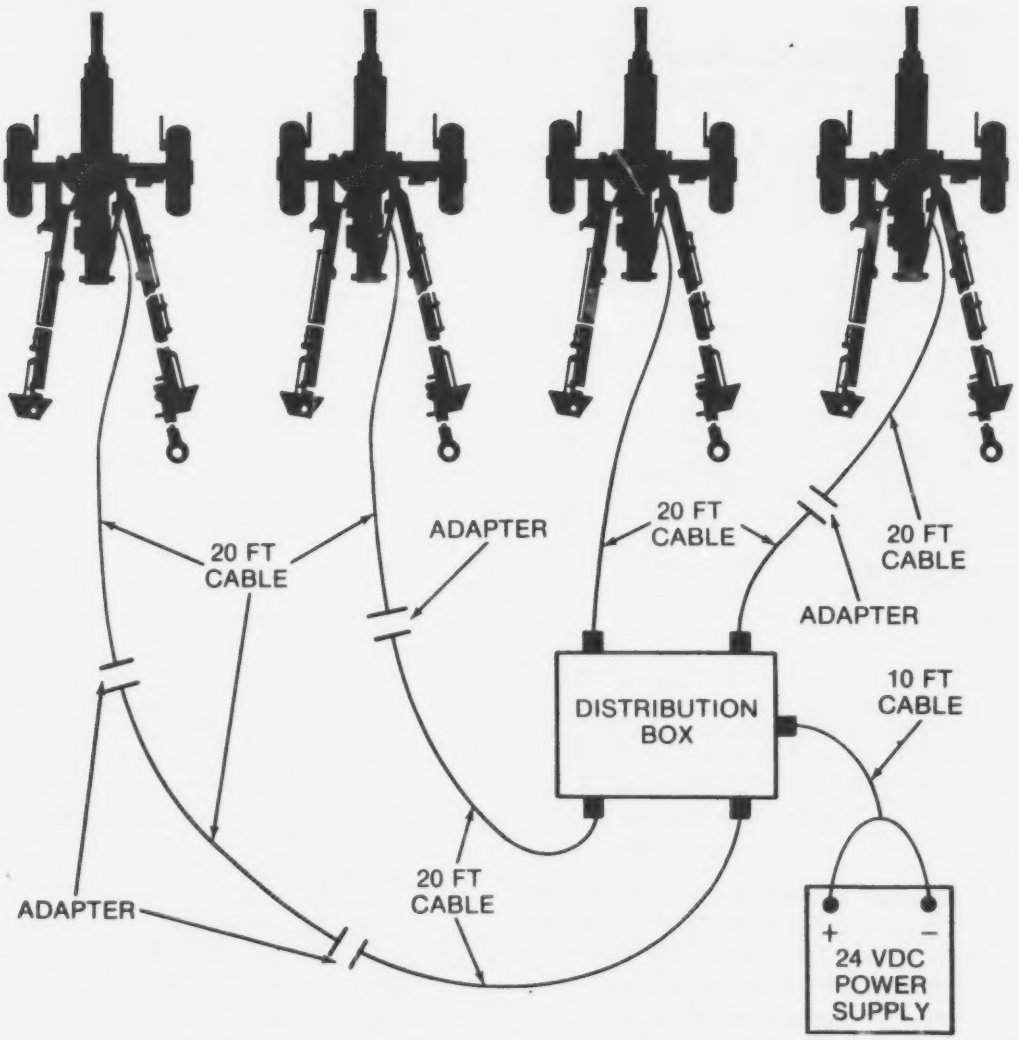
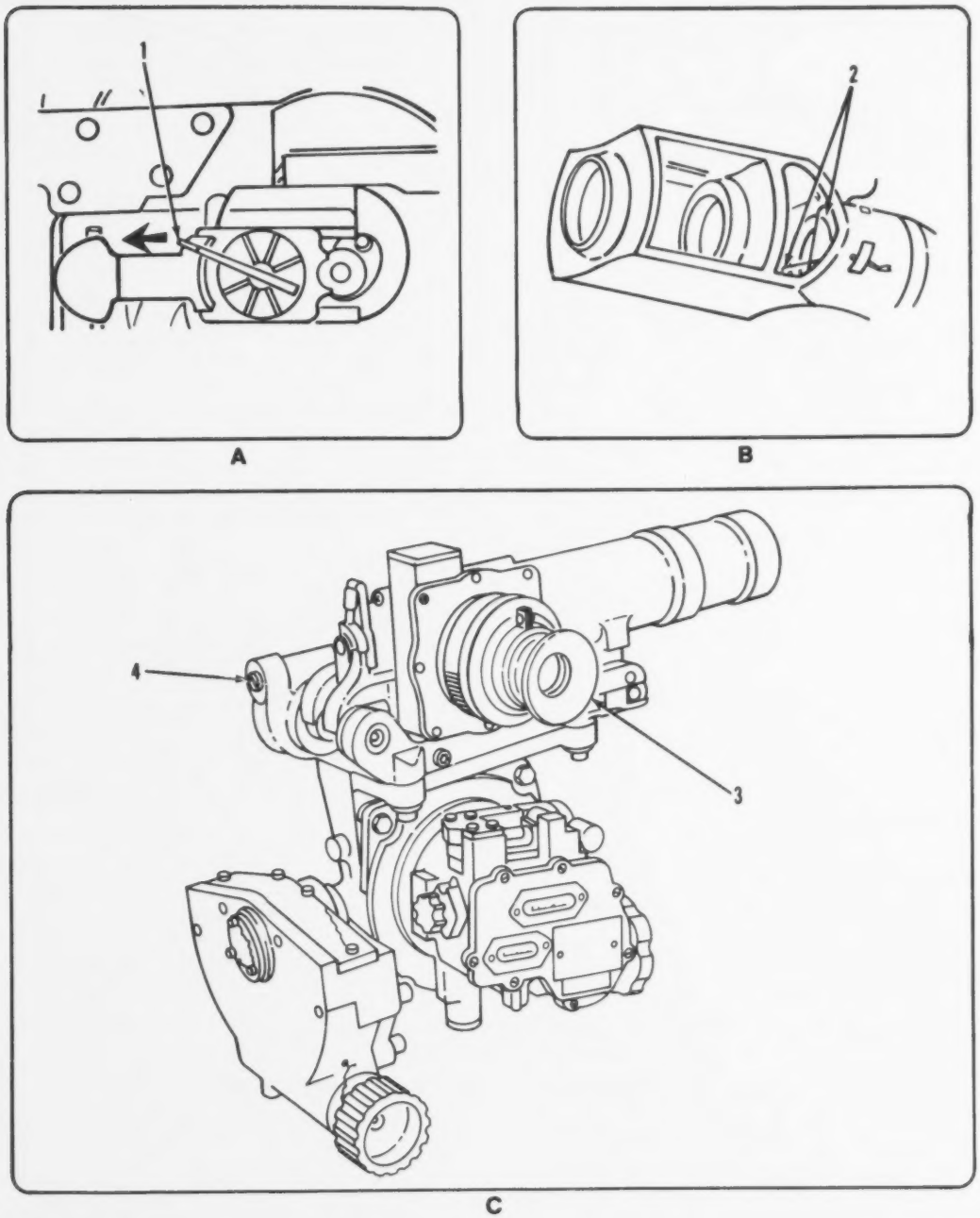


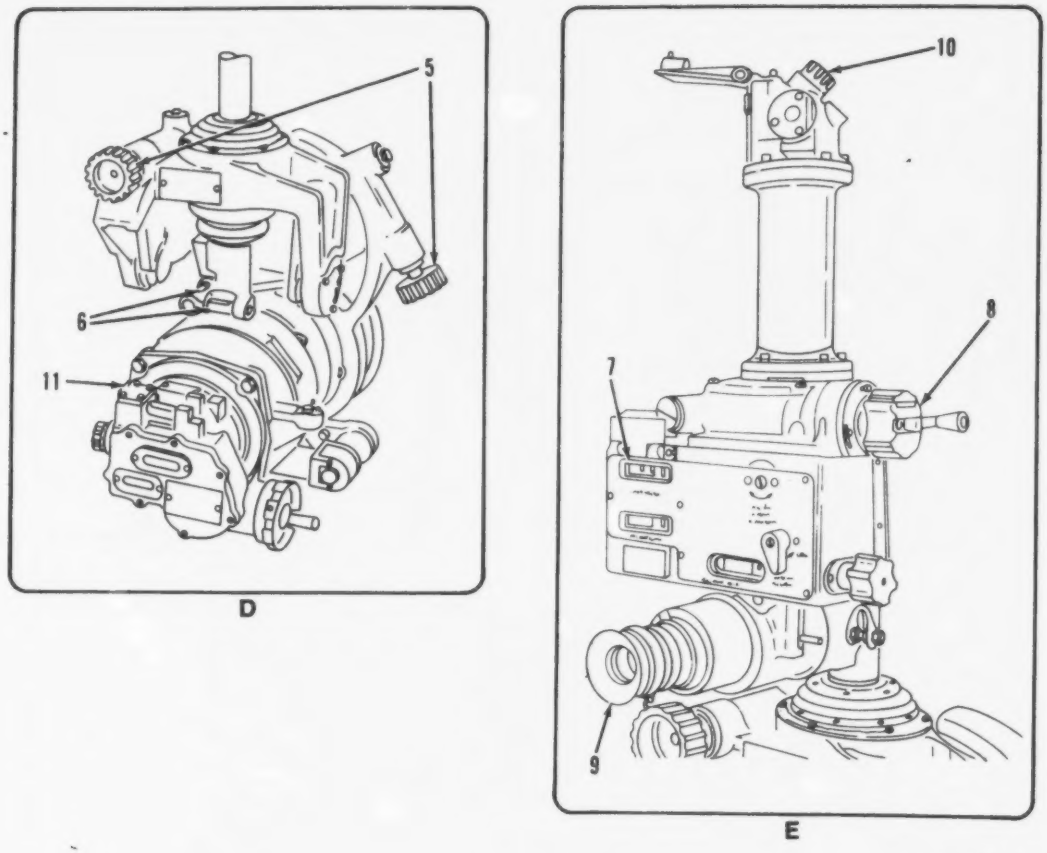
Figure 2-38. Multiple weapon operation



Legend for fig 2-39.

1. Block assembly
2. Crosshairs
3. Elbow telescope
4. Screw

Figure 2-39. Boresighting 155-mm M198 howitzer (1 of 2)



Legend for fig 2-39 - Continued.

5. Pitch and cross level knobs
6. Level vials
7. Azimuth counter
8. Azimuth knob
9. Panoramic telescope
10. Elevation knob
11. Level mount M171

Figure 2-39. Boresighting 155-mm M198 howitzer (2 of 2)

NOTE

The laser TRIGGER ON (3, fig 2-6) and LASER ON (4) indicator lamps illuminate as long as the BORESIGHT OFF FIRING switch (fig 2-10) is held in the BORESIGHT position.

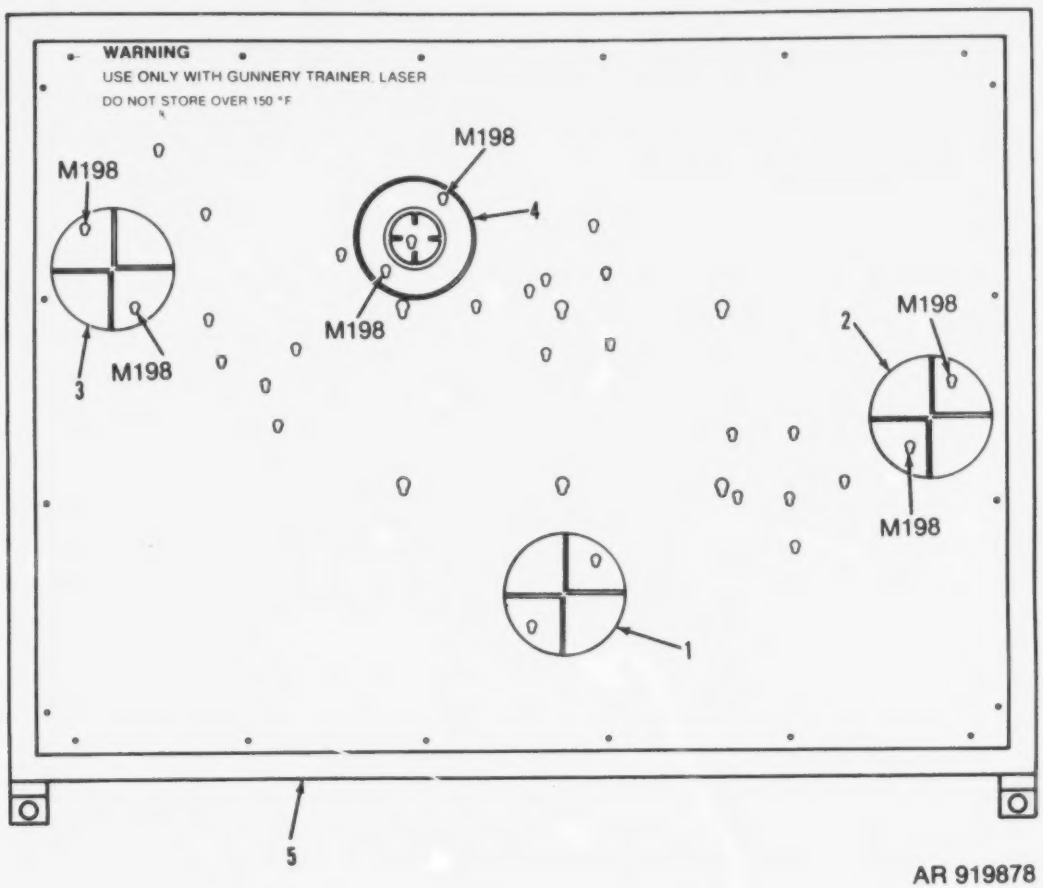
(18) Turn AZ knob (1, fig 2-5) and EL knob (2) until the laser beam is centered on laser target (4, fig 2-40). Slip both scales to zero.

NOTE

Check that at least 45 mils down deflection and 27 mils azimuth movement remain. If not, notify organizational maintenance.

(19) Release BORESIGHT OFF FIRING switch (fig 2-10). It is spring loaded and will return automatically.

(20) Set LASER SAFE FIRE circuit breaker switch (1, fig 2-6) to SAFE.



Legend for fig 2-40.
1. Cannon target - 11746461
2. M138 telescope target - 11746461
3. M137 pantel target - 11746461
4. Laser target - 11746464
5. Target support assembly

Figure 2-40. Installation of boresight targets for 155-mm M198 howitzer

(21) Set laser MODE CONT FLASH (2) to FLASH.

WARNING

If the laser trainer is not to be immediately operated, the power supply should be disconnected to prevent accidental firing of the laser.

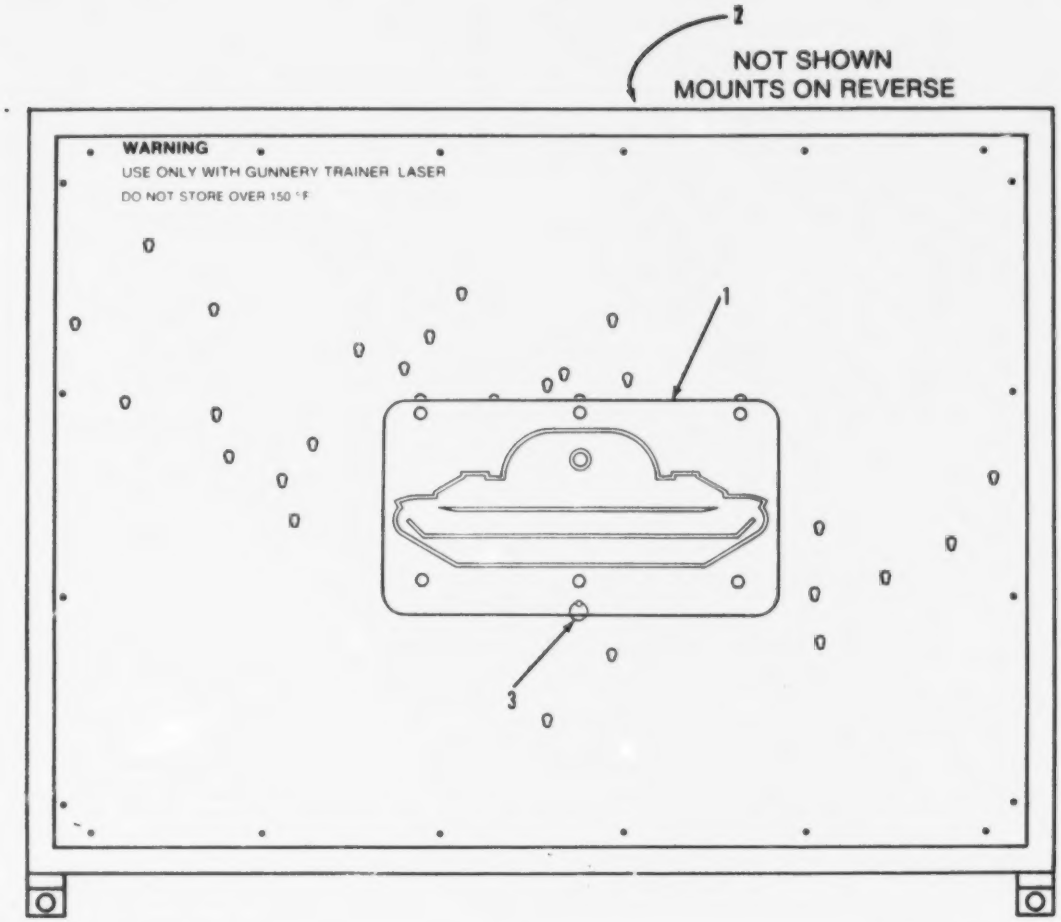
c. *Checkout Prior to Operation.*

WARNING

Before proceeding, make sure the LASER SAFE FIRE circuit breaker (1, fig 2-6) is set to SAFE and TRIGGER ON indicator lamp (3) is not illuminated.

(1) With the laser (6, fig 2-36) and deflector optical assembly (7) installed and ready for operation, proceed as follows: LASER SAFE FIRE circuit breaker (1, fig 2-6) set to SAFE, MODE CONT FLASH switch (2) is set to CONT, BORESIGHT OFF FIRING switch (fig 2-10) set to BORESIGHT and held. Oberve that TRIGGER ON indicator lamp (3, fig 2-6) illuminates.

(2) Place the BORESIGHT OFF FIRING switch (fig 2-10) in FIRING position and MODE CONT FLASH switch (2, fig 2-6) in FLASH position. Pull on LANYARD switch (16, fig 2-36) and observe that TRIGGER ON indicator lamp (3, fig 2-6) illuminates.



Legend for fig 2-41.
1. Target, moving - 11746475
2. Target, stationary (not shown) - 11746468
3. Pin - MS17987-C306

Figure 2-41. Installation of tank silhouette targets on trailer mounted target for 155-mm M198 howitzer

(3) Place the LASER SAFE FIRE circuit breaker (1) in FIRE position. While observing the target, note that a shot of laser light is emitted each time that either the BORESIGHT OFF FIRING switch (fig 2-10) is pressed or LANYARD (16, fig 2-36) is pulled.

(4) Set the LASER SAFE FIRE circuit breaker (1, fig 2-6) to SAFE.

(5) Set the BORESIGHT OFF FIRING switch (fig 2-10) to the OFF position.

WARNING

If the laser trainer is not to be immediately operated, the power supply should be disconnected to prevent accidental firing of the laser.

DEFLECTION TABLE
TRAINER, FIELD ARTILLERY: DIRECT FIRE
(LASER)

155 MM HOW. M198

Mounting Location: Recoil Mechanism, Rear of Gun

RANGE IN METERS		DEFLECTOR SETTINGS	
SIMULATED	ACTUAL	HORIZONTAL	VERTICAL D
		L	ADD TO GUN ELEV.
400	40	14.0	7.0
500	50	11.5	5.5
600	60	9.5	4.5
700	70	8.0	4.0
800	80	7.0	3.5
900	90	6.0	3.0
1000	100	5.5	3.0
1100	110	5.0	2.5
1200	120	4.5	2.5
1300	130	4.5	2.0
1400	140	4.0	2.0
1500	150	4.0	2.0
1600	160	3.5	2.0

Stationary Target: Deflector settings shown on chart.
Vertical Settings Shown on Chart Plus Gun Elevation.

Moving Target: Set the Horizontal deflection for the target range and then slip the scale to zero. If the target is moving from left to right the deflector setting will be "left" (L) and for a target moving from right to left the setting will be "right" (R). Elevation deflector settings shown on chart plus gun elevation. Additional elevation settings, determined by the degree of azimuth change and direction, is given in the table below.

Azimuth Change Left	**0-10**		**11-15**		**16-21**		**22-25**
Add to Elev Deflection Setting	**0**	+	**0.5**	+	**0.5**	+	**1.0**
Azimuth Change Right	**0-10**		**11-15**		**16-20**		**21-25**
Add to Elev Deflection Setting	**0**		**0**	+	**.5**	+	**1.0**

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Figure 2-42. Deflection table M198

d. *Operation.*

(1) Remove all target assemblies (1,2,3,4, fig 2-40) from target support assembly (5). Mount required tank silhouette targets (1,2, fig 2-41), one on each side of the target board, at its designated location on the target support assembly (5, fig 2-40) and secure with quick disconnect pin (3, fig 2-41) attached to target (1).

(2) Normal firing procedures for the M198 howitzer will be followed with the instructor making all the deflector assembly adjustments (app D). For this training exercise the 155-mm M198 Howitzer deflection table (fig 2-42) will be used for parallax correction, and for all inputs at all applicable ranges. Refer to applicable portions of the deflection table (fig 2-42) and to Appendix D for moving target training instructions and inputs.

(3) Set the laser MODE CONT FLASH switch (2, fig 2-6) to FLASH.

(4) Set the LASER SAFE FIRE circuit breaker (1) to FIRE.

(5) Set the BORESIGHT OFF FIRING switch (fig 2-10) to the FIRING position. Pull the LANYARD switch (16, fig 2-36) and the laser will emit one shot of laser light visible on the retroreflective target for each pull. The laser TRIGGER ON (3, fig 2-6) and LASER ON (4) indicator lamps illuminate each time the LANYARD switch (16, fig 2-36) is pulled.

(6) After completion of exercise, set the LASER SAFE FIRE circuit breaker switch (1, fig 2-6) to SAFE and the BORESIGHT OFF FIRING switch (fig 2-10) to OFF.

e. *Removal of Laser.*

WARNING

Make sure the LASER SAFE FIRE circuit breaker switch (1, fig 2-6) is set to SAFE and the BORESIGHT OFF FIRING switch (fig 2-10) is set to OFF.

(1) Install plug assembly (22, fig 2-36).

(2) Disconnect cable assembly (10 ft) (19) from power source and distribution box (18).

(3) Remove cable assembly (20 ft) (20, fig 1-2) and adapter cable assembly (8) if used.

(4) Disconnect cable assembly (20 ft) (17, fig 2-36) from distribution box (18) and control box (14).

(5) Disconnect LANYARD switch (16) from weapon lanyard and from control box (14).

(6) Disconnect cable assembly (15) from 1J1 connector on the underside of the laser (6).

(7) Loosen wing nut (21) and remove ground wire (11) from mount (12).

(8) Loosen thumbscrew (8) until light contact is maintained, unlock ring (10), and unscrew adapter (9).

(9) Loosen thumbscrew (8) completely and remove deflector optical assembly (7).

(10) Install lens guard (2, fig 2-37).

(11) Loosen hand knob (5, fig 2-36), open clamp (4) (leave clamp open for storage), and remove laser (6).

(12) Loosen hand knob (2) and remove mount assembly (1).

(13) Perform after firing PMCS and pack laser and trainer in their respective carrying cases and storage containers.

Section II. PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

2-8. **General.**

a. *Before You Operate.* Always keep in mind the CAUTIONS and WARNINGS. Perform your before (B) (table 2-2) PMCS.

b. *While You Operate.* Always keep in mind the CAUTIONS and WARNINGS. Perform your during (D) (table 2-2) PMCS.

c. *After You Operate.* Be sure to perform your after (A) (table 2-2) PMCS.

d. *If Your Equipment Fails to Operate.* Troubleshoot with proper equipment. Report any deficiencies using the proper forms, see TM 38-750.

2-9. **PMCS Procedures.**

a. *Item Number Column.* Checks and services are numbered in chronological order regardless of interval. This column shall be used as a source of item numbers for the "TM Number" column on DA Form 2404, Equipment Inspection and Maintenance Worksheet, in recording results of PMCS.

b. *Interval Columns.* The columns headed "B," "D," "A," and "W" contain a dot (•) opposite the appropriate check. Thus, if a given check is performed before operation, a dot is placed opposite the checks in the "B" column; if the check is accomplished during operation, the dot is placed in the column headed "D", and if the same check is made in two or more periods, a dot shall be placed in each applicable column.

c. *Item to be Inspected Column.* The items in this column are divided into groups indicating the portion of equipment of which they are part. The item to be inspected is identified by as few words, usually the common name, as will clearly identify the item.

d. *Procedures Column.* This column contains a brief description of the procedure by which the check is to be performed. It contains all the information required to accomplish the checks and services, including appropriate tolerances, adjustment limits, and instrument and gage readings.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services

NOTE: Within designated interval, these checks are to be performed in the order listed.
B-Before D-During A-After W-Weekly

Item No.	Interval B	D	A	W	Item to be Inspected	Procedures Check for and have repaired or adjusted as necessary
1	•				Laser	Inspect laser barrel assembly for any damage.
	•					Inspect laser lens assembly for cracked or broken lens.
		•				Check that laser operates properly as evidenced by laser firing (chapter 2, section 2).
			•			Wipe laser barrel assembly and barrel extension with wiping rags (item 6, app C).
			•			Apply a light coat of PL-S (item 4, app C) to unpainted surfaces.
	•					Inspect the optical lens for dust.
	•					Remove dust from optical lens using a clean camel-hair brush (item 1, app C).
	•					Inspect optical lens for any fingerprints, oil, or grease.
	•					Clean optical lens using alcohol (item 3, app C) and lens paper (item 5, app C).
			•			Check that laser and barrel extension are replaced properly in carrying case.
2	•				ADFT	Inspect mount assembly for any damage.
	•					Inspect deflector optical assembly for any damage.
	•					Inspect windows and lens in deflector assembly.
	•					Inspect cables and distribution box connectors for damage.
		•				Check that mount and deflector optical assembly operate properly when used with laser.
			•			Wipe mount and metallic surfaces of the deflector optical assembly with wiping rags (item 6, app C).
			•			Apply a light coat of PL-S (item 4, app C) to unpainted surfaces.
			•			Check that all equipment is properly stored in carrying cases.
	•					Inspect for cracked or broken level vials.
	•					Inspect optical windows for dust. Remove dust from optical windows with clean camel-hair brush (item 1, app C).
	•					Inspect optical windows for any fingerprints, oil, or grease.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services - Continued

NOTE: Within designated interval, these checks are to be performed in the order listed.
B-Before D-During A-After W-Weekly

Item No.	Interval B	D	A	W	Item to be Inspected	Procedures Check for and have repaired or adjusted as necessary
2 Cont.	•					Clean optical windows using alcohol (item 3, app C) and lens paper (item 5, app C).
	•					Check cables and lanyard switch for frayed or broken wires and that connectors are not damaged.
			•			Check all unpainted surfaces for dirt, grit, or gummed oil.
				•		Clean all unpainted surfaces of dirt, grit, or gummed oil using wiping rags (item 6, app C) and dry cleaning solvent (item 2, app C).
			•	•		Apply a light coat of PL-S (item 4, app C) to unpainted surfaces.
				•		Inspect base assemblies and support assembly for damage and clean all surfaces with wiping rags.
				•		Apply a light coat of PL-S (item 4, app C) to unpainted surfaces.
			•			Check shipping container for damage and clean interior and exterior surfaces. If damaged notify your supervisor.
	•					Inspect adapter assembly for damage to threaded surfaces and clean with wiping rags (item 6, app C).
				•		Apply a light coat of PL-S (item 4, app C) to unpainted surfaces.
				•		Inspect control box on deflector optical assembly for damage to components, cleanliness, and presence of all required items.
		•				Check for proper functioning during operation and wipe clean using wiping rags (item 6, app C).
			•			Insure plug assembly is installed on deflector optical assembly.
	•					Insure plug assembly is removed from deflector optical assembly.

CHAPTER 3
MAINTENANCE INSTRUCTIONS

Section I. LUBRICATION INSTRUCTIONS

3-1. **Lubrication.** No lubrication is required.

Section II. TROUBLESHOOTING

3-2. **Introduction.**

a. The table lists the common malfunctions which you may find during the operation or maintenance of the laser and ADFT or their components. You should perform the tests/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or is not corrected by the listed corrective actions, notify your supervisor.

Table 3-1. Troubleshooting

MALFUNCTION Test or inspection Corrective action
1. LASER DOES NOT FIRE AND TRIGGER ON LAMP DOES NOT LIGHT IN CONTINUOUS MODE.
Step 1. Check for loose power cable connection from control box to receptacle 1J1 on laser.
Tighten power cable connector.
Step 2. Check cable connections to control box assembly at distribution box and at power source.
Tighten power cable connections.
Step 3. Check for poor ground return.
Clean weapon and trainer mounting surfaces and be sure that ground cable from deflector optical assembly is connected.
Step 4. Check if deflector optical assembly is defective.
Notify organizational maintenance.
Step 5. Check if power source is defective.
Notify organizational maintenance.

Table 3-1. Troubleshooting - Continued

MALFUNCTION Test or inspection Corrective action
2. LASER FIRES BUT TRIGGER ON LAMP DOES NOT LIGHT.
Step 1. Check for loose TRIGGER ON lamp.
Tighten the TRIGGER ON lamp.
Step 2. Check for defective TRIGGER ON lamp.
Notify organizational maintenance.
3. LASER FIRES, BUT LASER ON LAMP DOES NOT LIGHT.
Step 1. Check for loose LASER ON lamp.
Tighten the LASER ON lamp.
Step 2. Check for defective LASER ON lamp.
Notify organizational maintenance.
4. LASER DOES NOT FIRE IN FLASH MODE.
Step 1. Check for loose power cable connection from control box to receptacle 1J1 on laser.
Tighten power cable connector.
Step 2. Check if lanyard switch connector is tight.
Tighten lanyard switch connector.
Step 3. Check if deflector optical assembly is defective.
Notify organizational maintenance.
Step 4. Check if power supply circuits are defective.
Notify organizational maintenance.
5. LASER CANNOT BE BORESIGHTED OR LASER SPOT CANNOT BE DEFLECTED ON TARGET.
Step 1. Check to see if the arrows and scribe marks on the alignment indicator are aligned.
Step 2. Check to see if the azimuth and deflector knobs are not in the center of free play when boresighted.
Notify organizational maintenance.

Section III. MAINTENANCE OF LASER AND ADFT

3-3. **General.** Laser and ADFT maintenance is not required in addition to the preventive maintenance checks and services at the operator/crew level. If maintenance is required, notify organizational maintenance.

APPENDIX A
REFERENCES

A-1. **Technical Manuals.** The following TM's are applicable to this publication.

TM 38-750	The Army Maintenance Management System (TAMMS)
TM 9-1015-203-12	Operator Crew and Organizational Maintenance Manual for Howitzer, Light, Towed: 105-mm, M101 (1015-322-9728) and M101A1 (1015-322-9752)
TM 9-1015-234-12	Operator and Organizational Maintenance Manual: Howitzer, Light, Towed: 105-mm, M102 (1015-086-8164)
TM 9-1025-200-12	Operator's and Organizational Maintenance Manual: Howitzer, Medium, Towed: 155-mm, M114 and M114A1
TM 9-2350-217-1ON	Operation and Maintenance Manual: (Crew) Howitzer, Medium, Self-Propelled: 155-mm, M109 (2350-00-440-8811) and 155-mm, M109A1 (2350-00-485-9662)

A-2. **Other Publications.** The following publications are related to information contained in this manual.

FM 21-6	Techniques of Military Instruction
FM 6-50	The Field Artillery Cannon Battery
TB-MED-279	Control of Hazards to Health from Laser Radiation

APPENDIX B
COMPONENTS OF END ITEM LIST

Section I. INTRODUCTION

B-1. **Scope.** This appendix lists integral components of and basic issue items for the trainer to help you inventory items required for safe and efficient operation.

B-2. **General.** This Components of End Item List is divided into the following sections:

a. *Section II. Integral Components of the End Item.* These items, when assembled, comprise the trainer and must accompany it whenever it is transferred or turned in. The illustrations will help you identify these items.

b. *Section III. Basic Issue Items.* These are the minimum essential items required to place the trainer in operation, to operate it, and to perform emergency repairs. Although shipped separately packed they must accompany the trainer during operation and whenever it is transferred between accountable officers. The illustrations will assist you with hard-to-identify items. This manual is your authority to requisition replacement BII, based on TOE/MTOE authorization of the end item.

B-3. **Explanation of Columns.**

a. *Illustration.* This column is divided as follows:

(1) *Figure number.* Indicates the figure number of the illustration on which the item is shown.

(2) *Item number.* The number used to identify item called out in the illustration.

b. *National Stock Number.* Indicates the National stock number assigned to the item and which will be used for requisitioning.

c. *Part Number.* Indicates the primary number used by the manufacturer, which controls the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspection requirements, to identify an item or range of items.

d. *Description.* Indicates the Federal item name and, if required, a minimum description to identify the item.

e. *Location.* The physical location of each item listed is given in this column. The lists are designed to inventory all items in one area of the major item before moving on to an adjacent area.

f. *Usable on Code.* Not applicable.

g. *Quantity Required (Qty Reqd).* This column lists the quantity of each item required for a complete major item.

h. *Quantity.* This column is left blank for use during an inventory. Under the Rcv'd column, list the quantity you actually receive on your major item. The Date columns are for your use when you inventory the major item at a later date; such as for shipment to another site.

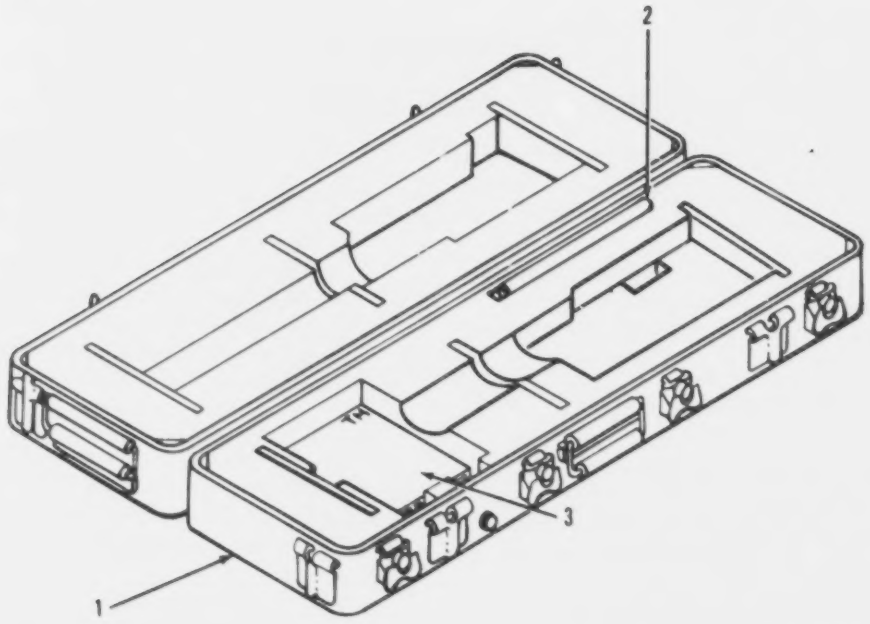

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Figure B-1. ICOEL for laser

Section II.
INTEGRAL COMPONENTS OF THE END ITEM

(1) ILLUS.		(2)	(3)	(4)	(5)	(6)	(7)	(8) QUANTITY			
(a) FIG. NO.	(b) ITEM NO.	NATIONAL STOCK NUMBER	PART NO.	DESCRIPTION	LOCATION	USABLE ON CODE	QTY REQD	RCV'D	DATE	DATE	DATE
				LASER, GUNNERY TRAINER: M55, W/E							
B-1	1		11743778	CASE, LASER, CARRYING			1				
B-1	2		11741689	BARREL, EXTENSION			1				
B-1	3			TM 9-6920-357-10-1			1				

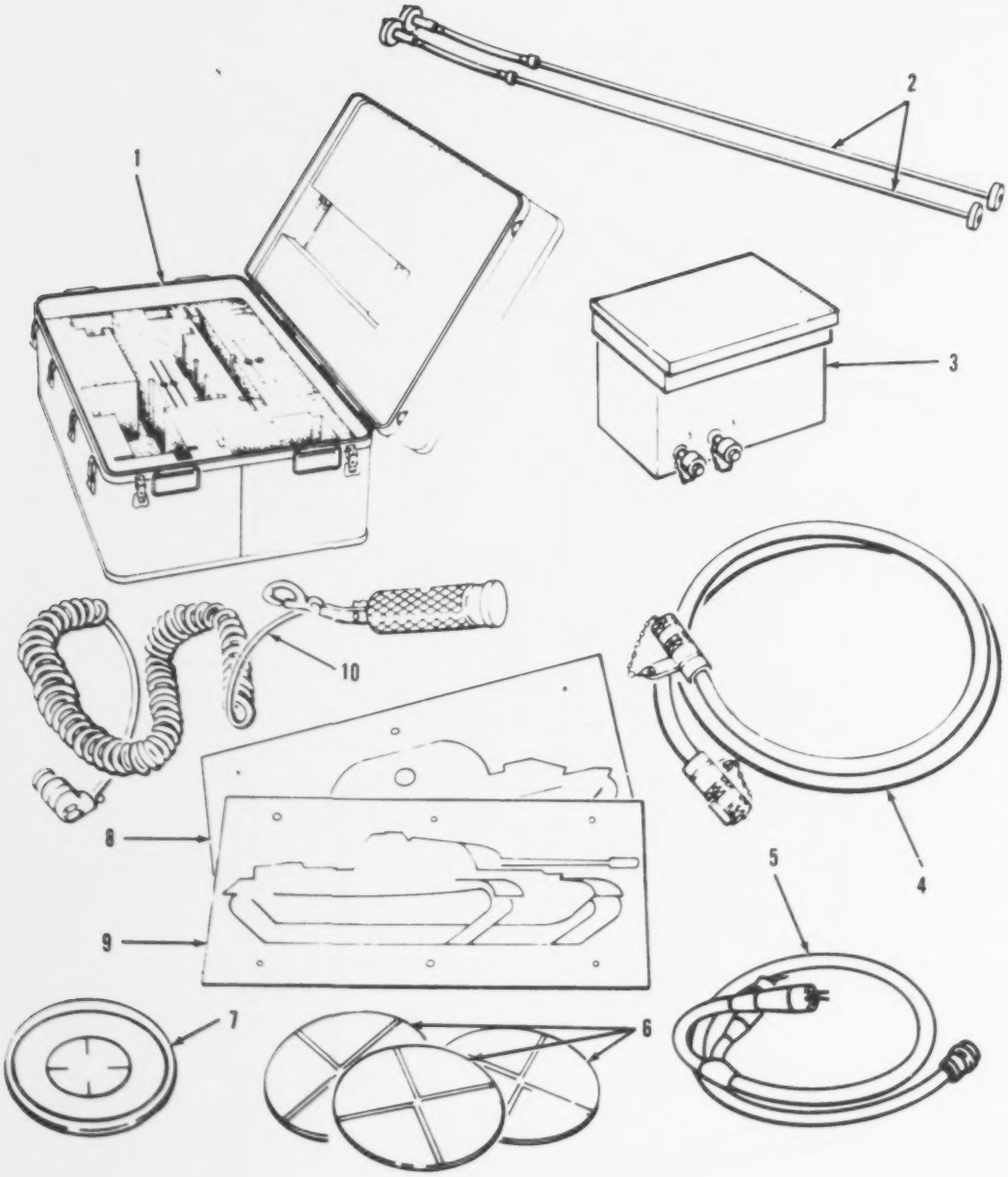

Figure B-2. ICOEL for ADFT (1 of 2)

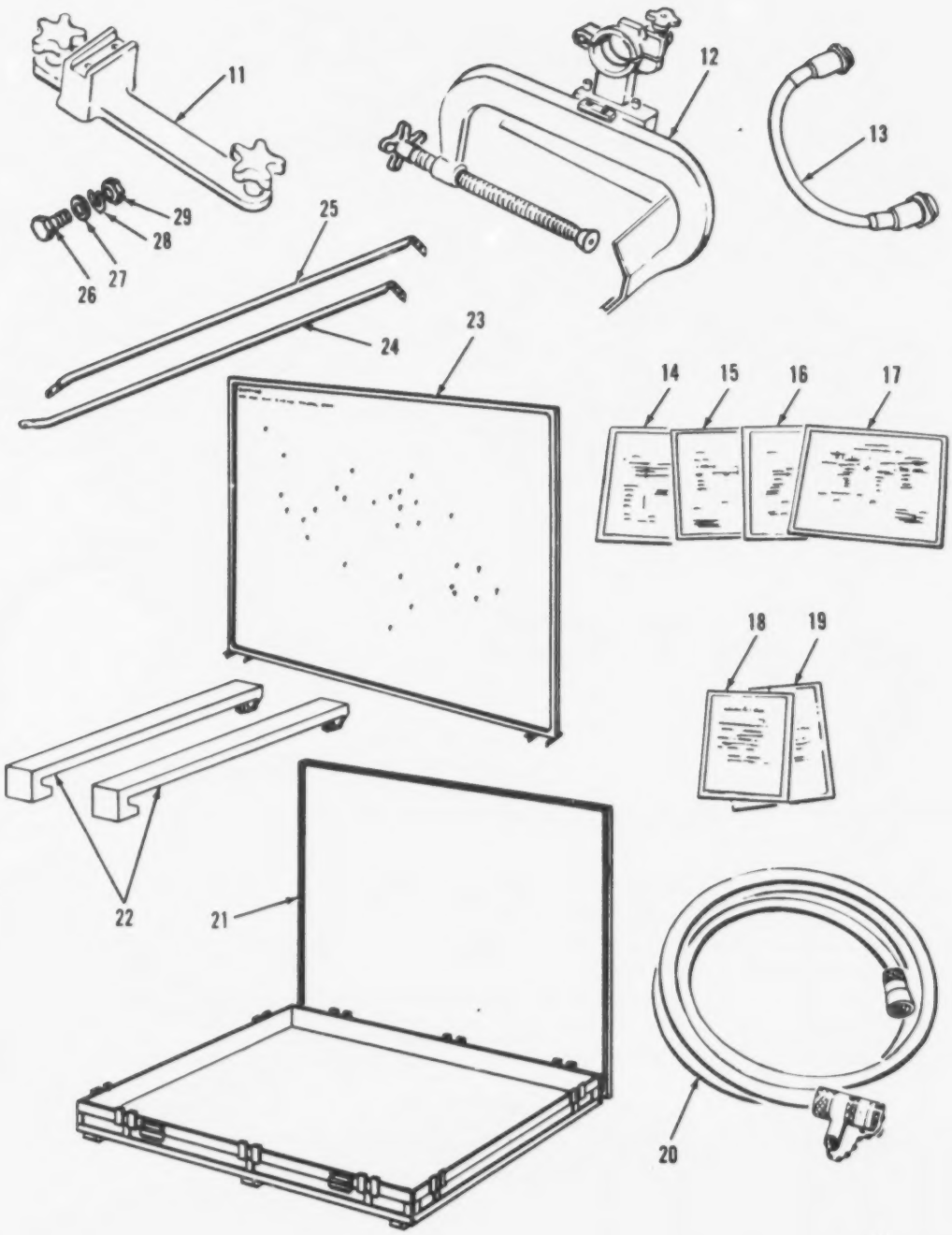

Figure B-2. ICOEL for ADFT (2 of 2)

(1) ILLUS		(2)	(3)	(4)	(5)	(6)	(7)	(8) QUANTITY			
(a) FIG NO.	(b) ITEM NO.	NATIONAL STOCK NUMBER	PART NO.	DESCRIPTION	LOCATION	USABLE ON CODE	QTY REQD	RCV'D	DATE	DATE	DATE
				TRAINER, FIELD ARTILLERY: DIRECT FIRE (W/O LASER)							
B-2	1	6920-01-051-2016	11747158	CASE, CARRYING			1				
B-2	2	5340-01-027-4218	11746446	CONTROL ROD			2				
B-2	3	6110-01-032-5121	11746450	DISTRIBUTION BOX			1				
B-2	4	6920-01-025-4597	11746452	CABLE ASSEMBLY			3				
B-2	5	6920-01-033-3683	11746454	CABLE ASSEMBLY			1				
B-2	6	6920-01-028-4572	11746461	TARGET ASSEMBLY			3				
B-2	7	6920-01-024-9050	11746464	TARGET ASSEMBLY			1				
B-2	8	6920-01-030-5224	11746468	TARGET ASSEMBLY			1				
B-2	9	6920-01-030-3418	11746475	TARGET ASSEMBLY			1				
B-2	10		11746480	SWITCH, LANYARD			1				
B-2	11		11747146	ADAPTER ASSEMBLY			1				
B-2	12	6920-01-025-4599	11747147	MOUNT ASSEMBLY			1				
B-2	13		11747152	CABLE ASSEMBLY ADAPTER			1				
B-2	14	6920-04-025-4601	11747153	DEFLECTION TABLE FOR M101A1 HOWITZER			1				
B-2	15		11747154	DEFLECTION TABLE FOR M102 HOWITZER			1				
B-2	16	6920-01-028-4571	11747155	DEFLECTION TABLE FOR M114A1 HOWITZER			1				
B-2	17	6920-01-028-4570	11747156	DEFLECTION TABLE FOR M109A1 HOWITZER			1				
B-2	18	6920-01-026-9383	11747164	DEFLECTION TABLE FOR M109 HOWITZER			1				
B-2	19	6920-01-025-4598	11748077	DEFLECTION TABLE FOR M198 HOWITZER			1				
B-2	20	6920-01-024-9205	11747170	CABLE ASSEMBLY			1				
B-2	21	8140-01-037-6338	11747167	CONTAINER, SHIPPING AND STORAGE			1				
B-2	22	6920-01-027-8353	11746509	BASE ASSEMBLY			2				
B-2	23	6920-01-039-8539	11746502	SUPPORT ASSEMBLY			1				
B-2	24	6920-01-026-2972	10554643-1	SUPPORT, LEFT, TARGET			2				
B-2	25	6920-01-026-2973	10554643-2	SUPPORT, RIGHT, TARGET			2				
B-2	26	5305-00-207-8253	MS35307-308	SCREW, CAP			12				
B-2	27	5310-00-582-5677	MS15795-810	WASHER, FLAT			24				
B-2	28	5310-00-543-2740	MS35333-74	WASHER, LOCK			12				
B-2	29	5310-00-250-9477	MS35649-2254	NUT, PLAIN, HEXAGON			12				

Section III. BASIC ISSUE ITEMS

(1) ILLUS		(2)	(3)	(4)	(5)	(6)	(7)	(8) QUANTITY			
(a) FIG NO.	(b) ITEM NO.	NATIONAL STOCK NUMBER	PART NO.	DESCRIPTION	LOCATION	USABLE ON CODE	QTY REQD	RCV'D	DATE	DATE	DATE
				NONE							

APPENDIX C
EXPENDABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

C-1. **Scope.** This appendix lists expendable supplies and materials you will need to operate and maintain the laser and trainer. These items are authorized to you by CTA 50-970, Expendable Items (Except Medical, Class V, Repair Parts, and Heraldic Items).

C-2. **Explanation of Columns.**

a. *Column 1 - Item Number.* This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e.g., "Use dry cleaning solvent, item 2, app C").

b. *Column 2 - Level.* This column identifies the lowest level of maintenance that requires the listed item.

C - Operator/Crew

c. *Column 3 - National Stock Number.* This is the National stock number assigned to the item; use it to request or requisition the item.

d. *Column 4 - Description.* Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the part number followed by the Federal Supply Code for Manufacturer (FSCM) in parentheses, if applicable.

e. *Column 5 - Unit of Measure (U/M).* Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

Section II. EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
1	C	8020-00-262-9099	BRUSH, ARTIST'S: camel-hair H-B-118 (81348)	EA
2	C	6850-00-264-9039	DRY CLEANING SOLVENT: P-D-680 (81348) 1 gal can	GL
3	C	6505-00-104-9000	ETHYL ALCOHOL, TECHNICAL: 95 percent (for cleaning optics of sighting and fire control equipment) JAN-A-463 (81348) 5 gal drum	GL
4	C	9150-00-231-6689	LUBRICATING OIL, GENERAL PURPOSE: special preservative (PL-S) VV-L-800 (81348) 1 qt can	EA
5	C	6640-00-663-0832	PAPER LENS: tissue, sheet form NNN-P-40 (81348) 50 sheets/bk	EA
6	C	7920-00-205-1711	RAGS, WIPING: cotton, bleached or unbleached, mixture of white or colored, designed for general purpose use DDD-R-30 (81348) 50 lb bundle	LB

APPENDIX D
TRAINING

Section I. ADMINISTRATIVE REQUIREMENTS

D-1. **General.** This appendix provides training guidance to the user and training manager. The appendix is not a directive; rather, it is intended to answer questions, provide general training guidance, and give solutions to training problems associated with direct fire training.

D-2. **Administrative Requirements.** The laser is issued to Div Artys in Europe and Korea (three each), separate brigades and ACR's in Europe and Korea (one each), and TASO's in all other areas of the world (one for every three 105/155mm units supported). (Note: M55 lasers are also issued to armor battalions worldwide). Table D-1 outlines the basis of issue and illustrates the administrative requirements associated with ADFT training.

Table D-1. ADFT Adapter Kits

LOCATION	CONTROLLING AGENCY	DOCUMENTS REQUIRED FOR ISSUE	DOCUMENTS REQUIRED FOR TURN IN	METHOD OF DELIVERY/ TURN IN	LOST OR DAMAGED	REMARKS
ALL AREAS	User Bn	Unit SOP	Unit SOP M55 LASER	Unit SOP	Lost: Report of survey Damaged: Repair thru supply & maint channels	2
USAREUR/ Korea	Div Arty SPE BDE ACR HQ	Unit SOP	Unit SOP	Unit SOP	Lost: Report of survey Damaged: Turn in	2
ALL OTHER AREAS	TASO	3 cys of DA 3161	3 cys of DA 3161	a. Active units: Pick up at TASO b. AR/NG: Freight delivery to unit	Lost: Report of survey Damaged: Repair thru supply & maint channels	1

REMARKS:
1. Shipments by TASO to supported unit are funded by TASO. The shipment of the device back to TASO is funded by the supported unit.
2. Documents required for issue and turn in will be established by battalion SOP. However, as a general rule DA 3122 would be used in an intra-battalion operation.

Section II. LASER SAFETY REQUIREMENTS

D-3. **General.** Since the ADFT is a laser device there are specific safety requirements in AR 385-63 that must be satisfied. This section specifies the minimum safety requirements for the M55 laser.

D-4. **M55 Laser Instruction.** All personnel must receive safety instruction prior to the use of the M55 laser. Reference publications should be available and used during the instruction. The instruction must consist of the following:

a. *Principles of Reflection/Refraction of Light.* Ensure that personnel are familiar with the following information.

(1) Conventional light sources, such as an electric lamp, send their light out in all directions. The light bulb directly viewed looks like an extended (large) source, and not a brilliant point source as does a laser. Figure D-1 shows how laser light can be focused by the eye into a very small spot on the retina. Compared with viewing a tank searchlight at 100 meters, a laser rangefinder would appear more than 100 million times brighter. The M55 laser is low energy and not nearly as hazardous as a laser rangefinder, but looking directly into the source is absolutely prohibited.

(2) Only certain surfaces are shiny enough to cause hazardous reflections (e.g., glass, chrome, standing water, and other mirror-like surfaces). Follow this rule: If you can see your reflection in the surface it will cause a hazardous reflection.

(3) A mirror-like ("specular") reflection is a significant hazard only if the reflecting surface is flat. Curved surfaces (such as chrome bumpers and wraparound windshields) will spread the beam and so hazardous conditions exist only within a few meters of those surfaces (fig D-2).

(4) The hazard of looking into a direct beam ("intrabeam viewing") is greatly increased when using a magnifier such as a pair of binoculars, a battery commander's (BC) scope, or a telescopic sight in an armored vehicle. In effect, the viewer is placed closer to the laser by a factor of the magnifying power of the sight. For example, if you are 1,000 meters from the laser source, the hazard, when looking through an 8X scope, is equivalent to the unaided eye located 125 meters from the source.

(5) Laser radiation should not be confused with ionizing radiation, such as X-rays and gamma rays. The biological effects of laser radiation are essentially those of visible, ultraviolet or infrared radiation upon tissues. However, radiant intensities typically produced by lasers are of magnitudes that could previously be approached only by the sun, nuclear weapons, burning magnesium, or arc lights. This is one of the important properties that make lasers potentially hazardous. The M55 laser presents no hazard to the skin and little hazard to the eye. However, damage can be caused to a person who stares at the laser beam when it is in the continuous mode.

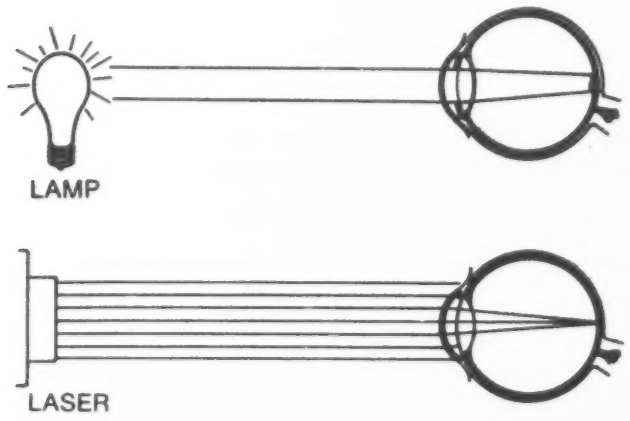

Figure D-1. Laser source

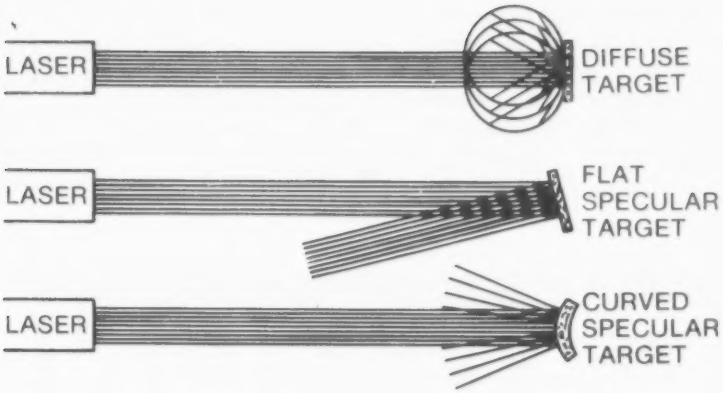

Figure D-2. Laser reflection

NOTE

Under no circumstances will anyone be allowed to stare into the M55 laser beam while the laser is in the continuous mode.

(6) Protective equipment is not required for the M55 laser system.

(7) The instructor will ensure that all personnel are thoroughly knowledgeable of unit safety standards and operational control procedures for laser range firing.

b. *Duties of the Laser Range Safety Officer (LRSO).* The LRSO must be a commissioned or noncommissioned officer. Specific duties are outlined below:

(1) The LRSO will thoroughly instruct all personnel authorized to participate in the laser operation regarding safety precautions.

(2) The LRSO will ensure that safe standing operating procedures are implemented and that the appropriate buffer zones are observed. Any entrance of personnel into the laser range danger fan area will terminate laser operation.

(3) Construction of the laser range danger fan will be accomplished as shown in figure D-3.

(a) No vertical buffer zone or back stop is required.

(b) The safety officers aid, if available from TASO, may be used in lieu of range poles to mark deflection limits.

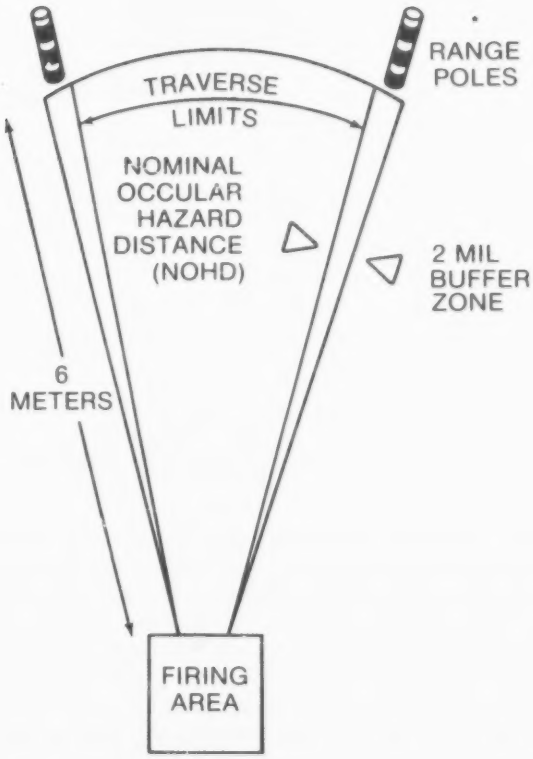

Figure D-3. M55 laser range danger fan

(4) Warning signs will be placed in a manner that will preclude entry into the laser range danger fan (LRDF) area. Figure D-4 shows a sample sign.

(5) The LRSO will ensure that the laser is operated in the continuous mode only during boresighting. A suggested procedure for boresighting is to have someone stand in front of the laser so the beam when turned on shines on his back. He then walks slowly toward the testing target (laser target board) as the beam is moved to follow him. This will ensure that the laser beam does not hit anyone in the eye when turned on. It is necessary as the beam is adjustable and does not necessarily point in the same direction as the howitzer tube.

(6) The LRSO will allow no one to view the laser source (intrabeam viewing) with magnifying optical devices such as binoculars or telescopes.

(7) Ensure that all specular surfaces are removed from the laser range danger fan area.

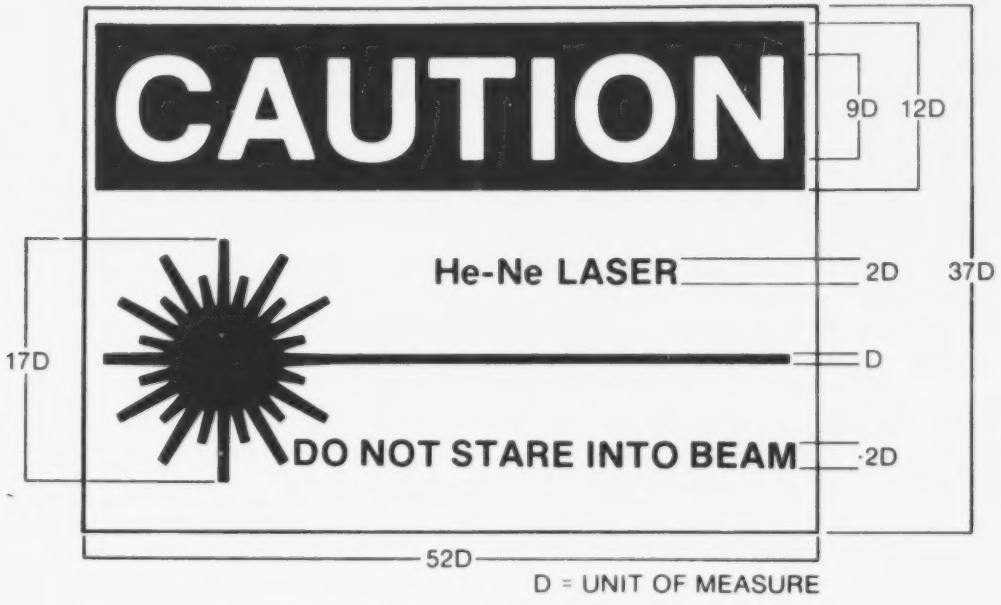

Figure D-4. Caution sign

Section III. TRAINING AREAS

D-5. **General.** "Train as you intend to fight" is the key statement to innovative training. The training area you plan and construct should promulgate that statement in every way possible. Many units do not have access to tactical training areas on a continuing basis, therefore, it is anticipated that many units will utilize motor pools and other similar areas as direct fire ranges. Innovation, then, becomes the name of the game. This section addresses many of the key issues governing the selection of a range site, and provides guidance on marking and preparing the range for use.

D-6. **Site Selection Considerations.**

a. *Size.* Table D-2 gives approximate dimensions for the range based upon traverse requirements. Since the state of training of the crew directly affects traverse requirements, a low state of training would necessitate more traverse.

b. *Location.*

(1) A site close to the using unit is preferable. This will save fuel and training time.

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Table D-2.

Traverse in Mils	Dimensions of Range (Range x Width)				
	40	80	120	160	Range to Target (Actual meters)
	X	X	X	X	
200	8	16	24	32	
400	16	32	48	64	
					Actual meters wide
600	24	48	72	96	
800	32	64	96	128	

The junction of range to target and traverse is the width of the range in meters in the target area.
EXAMPLE: a. If a space 160 meters long by 128 meters wide is available then the weapon can be traversed 800 mils during target engagement.

b. If 600 mils of traverse is required and a range to target of 120 meters is possible then a width of target area of 72 meters is required.

(2) The ground in the target area must be solid enough to withstand numerous crossings by the target vehicle, without deteriorating to a point requiring repairs.

(3) The target area terrain must be relatively smooth. A rapid change in elevation of the target would be unrealistic to the crew and it would most likely result in a target miss. The ADFT system is designed to operate on a 1-to-10 scale ratio. As shown in figure D-5 the target would move from the 400 meter range line to the N range line with a change in elevation of the target of one foot at a range of 40 meters. At the actual range of 400 meters the change in elevation would barely be perceptable.

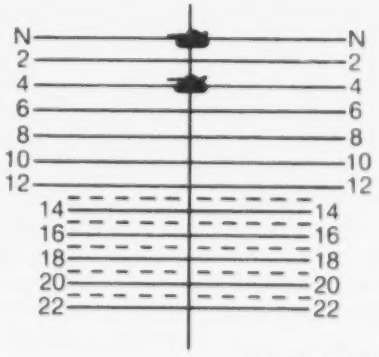


Figure D-5. Target range

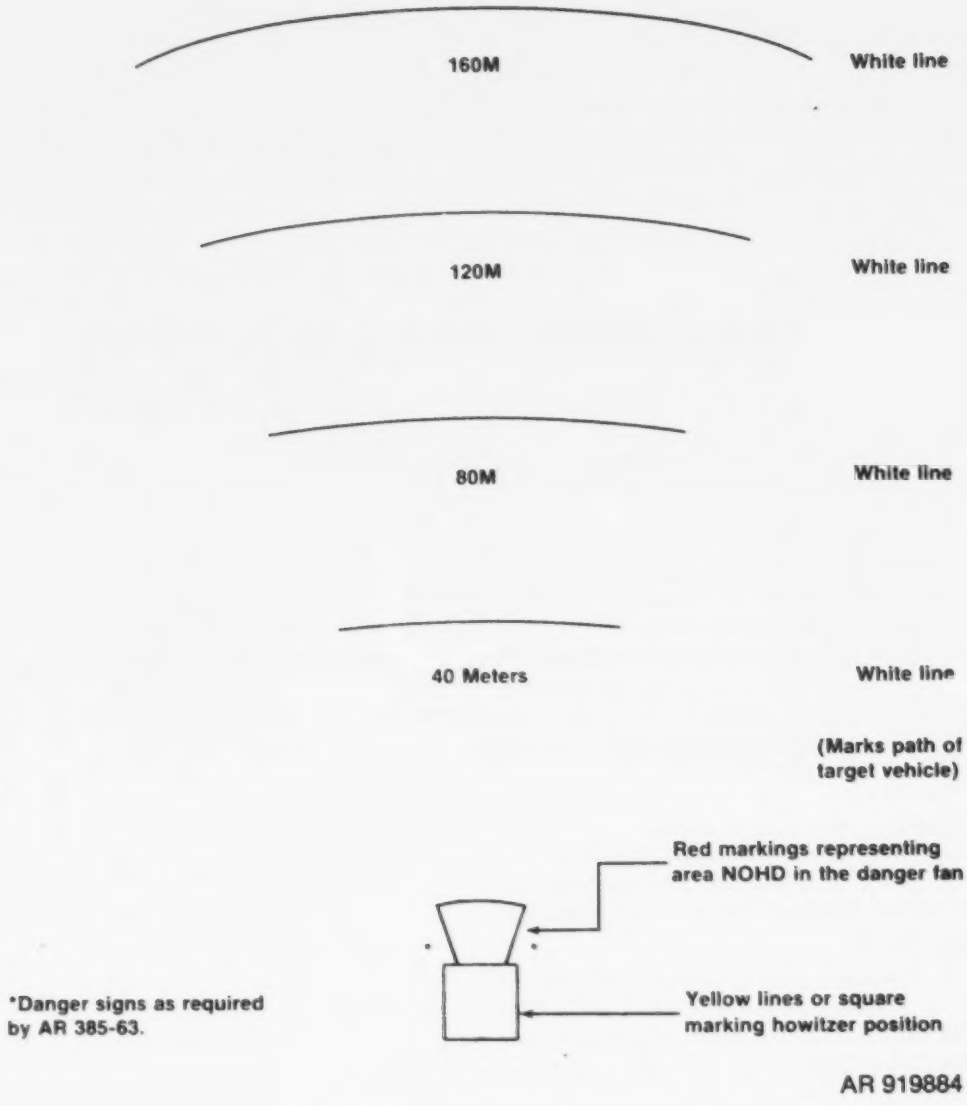


Figure D-6. Damper areas

(4) The area should be dedicated to direct fire training only. This will reduce maintenance requirements and avoid conflicts in scheduling.

(5) Use of the area for direct fire training must not cause interference with other activities; e.g., if a motor pool area is to be used a position must be selected which does not interfere with normal vehicle or foot traffic, or in any way degrade the activities of maintenance personnel.

c. *Preparation for Use.* Figure D-6 describes a method of marking the range to facilitate its use. The figure depicts a 160 x 96 meter range. All markings should be applied with paint, if possible, or if the range is on something other than a hard surface the markings can be applied using lime colored with paint pigments.

Section IV. CONDUCT OF TRAINING

D-7. **General.** This section addresses the conduct of direct fire training and is only part of the training problem. Once the crewmembers are thoroughly proficient in their tasks, the battery as a fighting unit, must rehearse those standing operating procedures that are designed to counter an infantry or armored threat against the battery position. To conduct an effective howitzer direct fire training program, the following phases of training should be performed.

D-8. **Commander's Evaluation and Planning.** The commander's initial evaluation and planning must precede the other phases but will continue throughout the entire program. There are five factors which must be considered as part of the evaluation. First, the commander must evaluate the unit's proficiency level in direct fire skills. Once determined, the commander must decide what training and resources are required to bring each crew up to the required training standard; and then, balance that against the time and resources available to establish the outline training plan. (See chapters 16 and 17 in the revised Field Manual 6-50).

D-9. **Pregunnery Training.** Pregunnery training should prepare each crewmember to perform those tasks required for him to conduct successful range training.

D-10. **Critical Tasks.**

NOTE

Pregunnery tasks are noted with an asterisk (*).

a. *Critical Leader Tasks.*

*(1) Prepare a range card.

*(2) Select appropriate target.

*(3) Select appropriate charge, fuze, projectile combination.

*(4) Estimate range to target.

*(5) Estimate speed of the target.

*(6) Give the correct fire command.

*(7) Give correct subsequent corrections.

b. *Critical Crewmember Tasks.*

(1) *Gunner.*

*(a) Level the panoramic telescope.

*(b) Correctly set the pantel to 3200.

*(c) Correctly set lead as commanded by the chief of section.

(d) Track the target continuously with the proper sight picture.

(e) Command "fire" when appropriate.

(f) Continue tracking target and apply corrections as announced by the chief of section.

(2) *Assistant Gunner.*

*(a) Crosslevel the direct fire telescope.

*(b) Lay on the target with the appropriate range line, as announced by the chief of section.

(c) Track the target in elevation maintaining the correct sight picture.

(d) Announce "set" continuously while the sight picture is correct.

(e) Apply range corrections as announced by the chief of section.

(f) Continue tracking target until it is destroyed.

(3) *Number 1 Man (Ammo Handler).*

*(a) Prepare ammunition as directed by the fire order.

(b) Load the howitzer as rapidly as possible.

(c) Fire the howitzer when commanded by the gunner.

NOTE

Standing operating procedures are not specifically addressed as a critical task. However the crew, as well as every member of the battery, must be thoroughly familiar with the unit's SOP and the commander's philosophy of how the howitzer battery will be defended.

D-11. **Direct Fire Skills/Knowledge Test.** The direct fire skills/knowledge test must be designed to determine if the individual performance levels of crewmembers are high enough to allow them to advance to collective, crew range training. The test should be conducted far enough in advance to allow for necessary remedial training. It should be comprehensive enough to ensure that all skills required for the conduct of firing have been mastered.

D-12. **Range Training.**

a. *General.* The range training phase of the training program is where manual skills will be reinforced and taught. The training should be in two phases. Initial training phase and subsequent/testing phase. Realism must be built into the range training as much as possible. FM 21-6 and TC 21-5-7 establish guidelines for developing the training program. This section will address specific problems that may occur and training innovations.

b. *Target Speed.* The driver of the target vehicle must maintain a constant speed when moving the target across in front of the howitzer. This can be accomplished by increasing the idle speed setting on the carbureator of the target vehicle so the vehicle moves smoothly in low range, second, third, and fourth gears. The speed of the target should be varied at each range line so the crews get practice with varying speeds of traverse. Target speed must not exceed 4 mph as, on a 1-to-10 ratio, 4 mph equates to 40 mph.

c. *Target Difficulty.* Target difficulty should be kept very low during initial training and realistically increased during subsequent training. During initial training target engagement time is relatively unimportant. The goal should be to increase manual skills. During advanced training, time is considered a critical factor. ARTEP standards should be met with time to spare. Several methods are available to increase target engagement difficulty.

(1) Limit the amount of traverse which in turn limits the engagement time allowed for the target.

(2) Have the target move into defilade, behind a simulated hill, depression, behind a parked vehicle, treeline or other obstacle, for a brief period of time so the crew has to make adjustments accordingly.

D-13. **Ammunition Handling.** The M55 laser does not require loading of the howitzer for operation. Consequently the crew receives no feel for reload time requirements and the loader receives no training. Innovation by the trainer is essential in this area. The 105-mm Ammunition Handlers Round is now available through TASO channels and can be used with the ADFT. The 155-mm units will not have an ammunition handlers round consequently the loading procedures must be simulated. An example of a method of simulation is shown below.

M109A1 Loading Simulation

a. Materials required .....
Empty powder containers. 3 ea
Expended primers. 3 ea
Dummy projectiles available at TASO.

b. Set up .....

(1) Store the powder containers in their appropriate position in the weapon.

(2) Place the projectiles in their appropriate positions in the howitzer.

(3) Disconnect the wire that goes to the rammer solenoid.

c. No. 1 Cannoneer's Required Action .....

(1) Upon hearing XO's command---
Removes rammer from stowed position to ram position.

(2) Upon receipt of chief of section fire order---

(a) Selects and removes appropriate projectile (assumption: projectiles carried in weapon fuzed).

(b) Places projectile on loading tray.

(c) Moves ram cylinder up into the ram position.

NOTE

At point c, the instructor or chief of section must monitor the time delay box at the upper rear of the cab turret. The instructor listens for a click in time delay box, and waits for the second click, which occurs in approximately 3 seconds and then allows the number 1 man to stow the rammer and continue the operation. This action will approximately equal cycle time of the rammer.

(d) Places rammer in the stowed position.
(e) Opens powder container (actual) and removes charge (simulated).

NOTE

Step e is unnecessary if unit SOP requires the chief of section to prepare the charge during direct fire.

(f) Simulates loading the charge.
(g) Closes the breech and announces "Close."
(h) Installs primer and closes firing block.
(i) Attaches lanyard.
(j) Fires on the command of gunner.
(k) Repeats the sequence.

D-14. **Target Scoring.**

a. The trainer/scorer should have the responsibility of accurately setting the laser for range and deflection. If the settings are incorrect the crew will be assessed with a target miss that is the trainer's fault. No useful training is received when that occurs.

b. A method of scoring initial training is depicted in figure D-7.

c. In a test situation a miss is a crew error and should be scored as such. In all cases the crew must be scored on a go/no go basis, based upon ARTEP and/or the commander's standards. The laser device is designed in such a way as to preclude the necessity of subsequent corrections. The crew, if all procedures are correct, should obtain first round hits.

d. Only one point is given for a first round hit because the laser beam has no time of flight. Score points are explained below.

(1) Keep a constant watch on the target board from the time the assistant gunner announces "Set" until the laser spot is visible on the target board. It's only visible for 0.25 of a second.
(2) If the laser spot touches any portion of the silhouette a hit will be scored. Everything else is a miss.
(3) Announce "Hit" or "Miss" for each round fired, loud enough for the crew and evaluator to hear.
(4) Upon completion of event seven, total the score and give the score sheet to the evaluator.

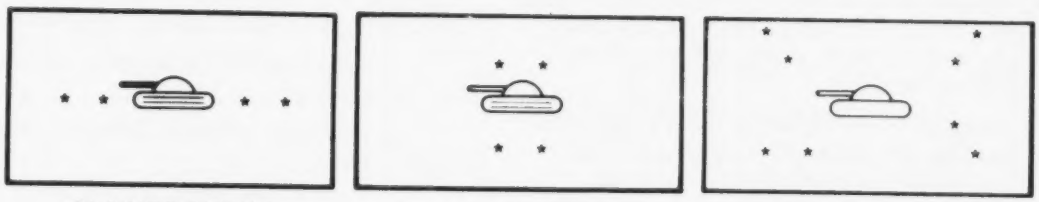


Figure D-7. Scoring of initial firing

Section V. EXAMPLES OF EVALUATION CHECKLISTS

D-15. **General.**

a. Paragraphs D-16 thru D-33 provide examples of evaluation checklists to be used as a guide in establishing the qualifications of howitzer crews to perform direct fire. These examples are based on the following commander's guidance.

(1) *Task.* Each howitzer section will engage moving targets with the howitzer main armament using direct fire procedures.

(2) *Conditions.* As a section, given a howitzer, with the ADFT mounted, emplaced in a suitable position, the crew will engage moving targets at ranges between 40 (400) and 160 (1600) meters.

(3) *Standards.* Each howitzer section must fire six missions. Each mission consists of two rounds fired within 40 seconds. Hits which occur in a mission that exceeds 40 seconds will not be counted. The crew must score a minimum of eight hits.

b. Paragraphs D-16 thru D-21 contain an example of a prerange training evaluation checklist. Its purpose is to determine if the crew is ready to proceed to actual range training.

c. Paragraphs D-22 thru D-27 contain an example of a range training evaluation checklist. This checklist is to be used during range training to evaluate the progress of the crew.

d. Paragraphs D-27 thru D-33 contain a final evaluation checklist. Its purpose is to determine if the crew can achieve a set standard of performance.

e. The procedures contained in these examples must be expanded and/or modified to include and conform to the unit standing operating procedures and to the commander's standards of performance.

D-16. **Prerange Training Evaluation For M109A1 Howitzer Crew in Direct Fire Procedures.**

a. *Material and Equipment Required.*

(1) One ¼ ton vehicle.

(2) One ¼ ton trailer with the ADFT target board installed. Place the target 120 meters in front of the weapon approximately 100 mils off the azimuth of fire.

(3) One M109A1 howitzer with section equipment. Prepare the weapon as follows:

(a) Fire control equipment mounted, operational, and boresighted.

(b) Howitzer laid, aiming points established and the panoramic telescope aligned on an aiming point for indirect fire.

(4) One blank range card for each chief of section to be tested and an appropriate direct fire card.

(5) Two empty powder containers. If they are not available, simulate.

(6) Two dummy projectiles (available from TASO) and two mechanical time fuzes (INERT).

(7) Two inert or expended primers, and two inert charges 7 or 8.

(8) One correct range card appropriate to the weapon position.

(9) One stopwatch.

b. *Conduct of the Evaluation.* The evaluation will be conducted on an individual basis (see D-17 thru D-20).

D-17. **Evaluation of Chief of Section.**

a. *Evaluator.* Direct the chief of section to prepare a range card appropriate for this howitzer position.

NOTE

The chief of section should be allowed to use any materials or references he would normally have access to in combat.

b. *Performance Checklist.*

(1) Left and right limits accurate within one mil. GO NO-GO

(2) Appropriate targets and reference points illustrated. GO NO-GO

NOTE

Do not assess a NO-GO based on artistic ability.

(3) Appropriate firing data computed for targets as appropriate. GO NO-GO

NOTE

Format for range cards is contained in FM 6-50, chapter 7.

c. *Evaluator.* Inform chief of section target is moving at ___ mph. Command "Target that tank. Fire at will." GO NO-GO

d. *Performance Checklist.*

(1) All elements of fire order included and in correct sequence as applicable to unit SOP. GO NO-GO

(2) Projectile, charge, and fuze appropriate. May be standardized by unit SOP and need not be announced. GO NO-GO

(3) Lead within tolerance. GO NO-GO

(4) Range within tolerance. GO NO-GO

e. *Evaluator.* At this time provide the chief of section a spotting such as: "5 mils left and 200 meters over the target."

f. *Performance Checklist.*

(1) Subsequent command in correct sequence. GO NO-GO

(2) Subsequent command correct. Based on spotting provided by the evaluator. GO NO-GO

g. *Overall Rating.* Must be all GO's. GO NO-GO

D-18. **Evaluation of Gunner (Direct Fire).**

a. *Evaluator.*

(1) Give an appropriate fire command, such as: "Target that tank. Left front, lead left 5, range 600. Fire at will."

(2) Wait six seconds and start announcing "Set, Set, Set," until the gunner commands "Fire"

b. *Performance Checklist.*

(1) Centers the cross level vial bubble. GO NO-GO

(2) Applies the correct lead. GO NO-GO

(3) Turns the bar knob to DIRECT. GO NO-GO

(4) Traverses the tube until the sight picture is correct. GO NO-GO

(5) Commands "Fire." GO NO-GO

c. *Evaluator.* Check the sight picture, then command a lead change such as "Right 10."

d. *Performance Checklist.*

(1) Centers the cross level vial bubble. GO NO-GO

(2) Lead set correctly. GO NO-GO

(3) Sight picture correct. GO NO-GO

e. *Evaluator.* Command "End of mission."

f. *Overall Rating.* Must be all GO's. GO NO-GO

D-19. **Evaluation of Assistant Gunner.**

a. *Evaluator.* Give an appropriate fire command, such as: "Target that tank. Right front, shell HE charge 8, fuze quick, lead left 5, range 600. Fire at will."

NOTE

The howitzer must be laid for direction correctly at this point.

b. *Performance Checklist.*

(1) Cross level vial bubble centered. GO NO-GO

(2) Laid on target with appropriate range line and correct reticle. GO NO-GO

c. *Evaluator.* Check sight picture and announce "Close" indicating the weapon is loaded.

d. *Performance Checklist.* Announce "Set, Set, Set" until the command "Fire"is announced. GO NO-GO

e. *Evaluator.* Command "Fire." Pause and then give a correction such as "Left 5, add 200."

f. *Performance Checklist.*

(1) Cross level vial bubble centered. GO NO-GO

(2) Laid on target with appropriate range line. GO NO-GO

g. *Evaluator.* Announce "Close" indicating the weapon is loaded.

h. *Performance Checklist.* Announce "Set, Set, Set" until "Fire" is commanded. GO NO-GO

i. *Evaluator.* Command "Fire." Pause and then give a correction such as "Drop 100."

j. *Performance Checklist.*

(1) Cross level vial bubble centered. GO NO-GO

(2) Laid on target with appropriate range line. GO NO-GO

k. *Evaluator.* Announce "Close" indicating the weapon is loaded.

l. *Performance Checklist.* Announce "Set, Set, Set" until "Fire" is commanded. GO NO-GO

m. *Evaluator.* Command "Fire. End of mission."

n. *Overall Rating.* Must be all GO's. GO NO-GO

D-20. **Evaluation of Loader (Number One Man).**

a. *Evaluator.* Brief the crew member as follows:

(1) "You will be required to respond to a fire command for direct fire. You must complete all actions including actuating the firing mechanism within 30 seconds for two rounds. Ramming time will be induced into the test."

(2) Command "Target that tank. Shell HE, charge 8, fuze quick, lead left 5, range 800. Fire at will."

NOTE

Start the stopwatch.

b. *Performance Checklist.*

(1) Selects the correct ammunition. GO NO-GO

(2) Performs all loading actions correctly. GO NO-GO

(3) Announces "Close" when closing breechblock. GO NO-GO

c. *Evaluator.* Command "Fire."

d. *Performance Checklist.*

(1) Fires weapon immediately. GO NO-GO

(2) Prepares second round. GO NO-GO

(3) Performs all loading operations correctly. GO NO-GO

(4) Announces "Close" when closing breechblock. GO NO-GO

e. *Evaluator.* Command "Fire."

f. *Performance Checklist.* Fires weapon immediately. GO NO-GO

g. *Evaluator.* Stop the stopwatch. Time 30 seconds or less. GO NO-GO

h. *Overall Rating.* Must be all GO's. GO NO-GO

NOTE

Evaluator will follow sequence of events noted in the ammunition handling section under Range Training.

D-21. **Direct Fire Evaluation Checklist.**

a. *Conduct of the Test.*

(1) Require the chief of section to prepare a range card.

(a) Evaluate the card and brief the chief of section:

1. The card must meet the requirements of FM 6-50.

2. No score is given for preparation of the card. It is to be used to determine if any remedial training is required.

(2) Have the crew take their places in the howitzer.

(3) Set the azimuth and elevation controls of the laser in accordance with the lead card and the appropriate event number.

(4) Simultaneously

(a) Announce "Number 3 adjust, target that tank, fire at will." Target speed___from lead cards.

(b) Start the stopwatch.

(c) Signal the target vehicle driver to start.

(5) Monitor the actions of the crew. Record any discrepancies for the critique.

NOTE

You must control the loading procedures to ensure all actions are completed and the appropriate delay during ramming is simulated. Assess a 5-second penalty for any loading task omitted.

NOTE

When the second round is announced by the scorer as a HIT or MISS, stop the stopwatch, and record the time.

Event	Time	Remarks (list penalties or comments here)
1		
2		
3		
4		
5		
6		

D-22. **Example of Range Training Evaluation.**

a. *Material and Equipment Required.*

(1) A properly prepared laser range.

(2) One ¼ ton vehicle: Idle set high enough to allow the vehicle to idle smoothly in first, second, and third gear, low range.

(3) One ¼ ton trailer: ADFT target board properly mounted.

(4) One M109A1 howitzer with section equipment prepared as follows:

(a) Emplaced on the laser range.

(b) ADFT installed.

(c) Fire control mounted, operational and the howitzer laid properly.

(d) Aiming points established.

(e) Fire control and laser boresighted.

(f) Safety officers aid (TASO) installed and set (traverse only).

(5) One stopwatch (evaluator's use).

(6) One pair of binoculars (scorer's use).

(7) One blank range card for each section to be tested. Direct fire card as appropriate.

(8) Two empty powder containers (if available or simulate).

(9) Two dummy projectiles (if available or simulate).

(10) Two primers, inert.

(11) One properly prepared range card applicable to the howitzer position.

b. *Personnel Requirements.*

(1) Target vehicle driver (1 ea).

(2) Target observer scorer (1 ea).

(3) Evaluator/instructor.

(4) Laser range safety officer/NCO (1 ea).

c. *Administrative Requirements.*

(1) Schedule all support personnel to arrive on site early enough to set up all required equipment and be briefed on their duties.

NOTE

The evaluator must be a trained evaluator cognizant of all direct fire requirements and setting of the laser.

(2) Brief all personnel on laser safety.

(3) Schedule the chief of section, for each section, to arrive 30 minutes prior to his crew. During this 30 minutes, require the chief of section to prepare a range card. (Grade the range card for accuracy and content.)

NOTE

A deviation of 20 or 30 meters in range should not be considered an error.

(4) Brief the driver of the target vehicle (D-23).

(5) Brief the scorers (D-24).

(6) Brief the evaluator/instructor (D-25).

(7) Brief the personnel to be trained/evaluated (D-26).

D-23. **Briefing for Driver of the Target Vehicle.**

a. Give the driver a copy of the target schedule.

Event	Low Range Idle/Gear Position	Range Line	Direction	Special Instructions
1	2	80	Left to Right	
2	3	160	Right to Left	
3	2	120	Left to Right	
4	3	80	Right to Left	
5	3	160	Left to Right	
6	2	120	Right to Left	

b. Driver will maintain a constant speed in accordance with the target schedule.

c. Events will begin on the evaluator's signal. Notify the driver as to what the signal will be.

d. Each event will terminate at the terminal point of the range line. At that time the driver will move to the next range line as marked on the target schedule and await the signal to begin.

D-24. **Briefing for Scorer.**

a. Observe the target constantly from the time the assistant gunner starts announcing "Set" until you see the laser spot on the target board. It's only visible for 0.25 of a second.

b. Mark the score sheet and announce "Hit" or "Miss" as appropriate. If it's a miss announce who caused the miss.

c. Upon completion of the checklist or as required, give the checklist to the instructor. Passing score is 18 points.

SAMPLE CHECKLIST

(Scorer)

EVENT	ROUND	HIT	MISS	ERROR CAUSED BY GUNNER	ERROR CAUSED BY ASST GUNNER
1	1	1 pt	0 pt		
	2	4 pt	0 pt		
	3	0 pt	0 pt		
2	1	1 pt	0 pt		
	2	4 pt	0 pt		
	3	0 pt	0 pt		
3	1	1 pt	0 pt		
	2	4 pt	0 pt		
	3	0 pt	0 pt		
4	1	1 pt	0 pt		
	2	4 pt	0 pt		
	3	0 pt	0 pt		
5	1	1 pt	0 pt		
	2	4 pt	0 pt		
	3	0 pt	0 pt		
6	1	1 pt	0 pt		
	2	4 pt	0 pt		
	3	0 pt	0 pt		

TOTAL POINTS__TOTAL MISSES__

D-25. **Briefing for Evaluator/Trainer.**

a. As the trainer, you must ensure all errors of the crew are noted. You must reinstruct the crew and cause them to practice the correct procedures until they are completely qualified. At the conclusion of this training session you will prepare an evaluation summary stating the shortcomings of the crew if any.

b. Timing sequences must be recorded exactly.

c. A lead card and evaluation checklist are provided.

SAMPLE LEAD CARD

EVENT	TARGET SPEED (mph)	LASER SETTINGS HORIZONTAL	VERTICAL	RANGE
1	5	L11.0	12.5	80
2	15	R18.0	20.5	1600
3	10	L14.0	16.0	1200
4	25	R26.0	12.5	800
5	20	L23.0	20.5	1600
6	30	R34.0	16.0	1200

NOTE

This is a sample lead card, the settings may or may not be correct. The lead card your unit prepares should be established for each day's firing in the following manner.

d. Boresight the howitzer.

e. Place the target at each range to be fired and;

(1) Set the lead to be used on the panel and take up the correct sight picture.

(2) Take up the correct sight picture with the direct fire telescope.

(3) Place the laser in the continuous mode.

(4) Fire the laser and turn the azimuth and elevation knobs to align the laser spot on the center of the target.

(5) Record the readings on the laser elevation and azimuth scales.

(6) Repeat the procedures for each range and lead to be fired.

D-26. **Briefing for Personnel to be Trained/Evaluated.**

a. Your preliminary instruction has prepared you for this training. On this range is where you will begin to function as a team in direct fire situations. Your goal is to become qualified to defend your weapon and the battery in a manner that will increase your chances for survival.

b. During this training, feel free to ask assistance from the instructor at any time.

c. You will be timed during this training, so perform all tasks as accurately and as quickly as possible.

d. You will be required to engage moving targets at various ranges. You are required to fire a minimum of two rounds at each target, within 40 seconds. You may fire more than two rounds at any target for practice purposes. However, grading stops after 40 seconds.

e. Continue with these procedures until the test is completed.

f. Compare the score card with the times recorded for each event. Any event over 40 seconds will be rescored as a NO-GO and the total changed accordingly.

EXAMPLE

SCORE CARD

MISSION	TIME
Event 1	41 sec

Event	Round	Hit	Miss
1	1	GO	NO-GO
	2	GO	NO-GO
	3		

TOTAL 2 GO's. Over 40 sec - NO-GO Event 1

g. Critique the crew on their performance.

(1) 8 or more GO's SATISFACTORY

(2) 7 or less GO's UNSATISFACTORY

D-27. **Final Evaluation Checklist.**

a. *Material and Equipment Required.*

(1) A properly prepared laser range.

(2) One ¼ ton vehicle: Idle set high enough to allow the vehicle to idle smoothly in first, second, and third gear, low range.

(3) One ¼ ton trailer: ADFT target board properly mounted.

(4) One M109A1 howitzer with section equipment prepared as follows:

(a) Emplaced on the laser range.

(b) ADFT installed.

(c) Fire control mounted, operational, and the howitzer laid properly.

(d) Aiming points established.

(e) Fire control and laser boresighted.

(f) Safety officers aid (TASO) installed and set (traverse only).

(5) One stopwatch (evaluator's use).

(6) One pair of binoculars (scorer's use).

(7) One blank range card for each section to be tested. Direct fire card as appropriate.

(8) Two empty powder containers (if available or simulate).

(9) Two dummy projectiles (if available or simulate).

(10) Two primers, inert.

(11) One properly prepared range card applicable to the howitzer position.

b. *Personnel Requirements.*

(1) Target vehicle driver (1 ea).

(2) Target observer/scorer (1 ea).

(3) Evaluator /instructor (1 ea).

(4) Laser range safety officer/NCO (1 ea).

c. *Administrative Requirements.*

(1) Schedule all support personnel to arrive on site early enough to set up all required equipment and be briefed on their duties.

NOTE

The evaluator must be a trained evaluator cognizant of all direct fire requirements and setting of the laser.

(2) Brief all personnel on laser safety.

(3) Schedule the chief of section, for each section, to arrive 30 minutes prior to his crew. During this 30 minutes, require the chief of section to prepare a range card. (Grade the range card for accuracy and content.)

NOTE

A deviation of 20 or 30 meters in range should not be considered an error.

(4) Brief the driver of the target vehicle (D-28).

(5) Brief the scorers (D-29).

(6) Brief the evaluator/instructor (D-30).

(7) Brief the personnel to be trained/evaluated (D-31).

(8) Conduct of the evaluation (D-32).

(9) Sample checklist and sequence of events (D-33).

D-28. **Sample Checklist (Scorer).** See figure D-8 for a sample checklist.

D-29. **Briefing for Evaluator.**

a. The crew will reeeive a satisfactory or unsatisfactory as a score based on your evaluation.

b. You must be prepared to brief the crew on their shortcomings at the conclusion of the exercise.

c. All settings of the laser must be exact.

NOTE

A test firing of the laser at each range line should be conducted, before student arrival, to ensure the settings recorded on the lead card are exact.

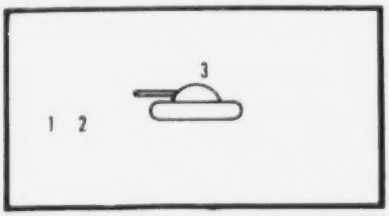
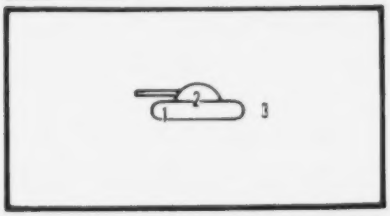
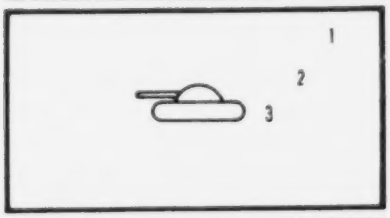
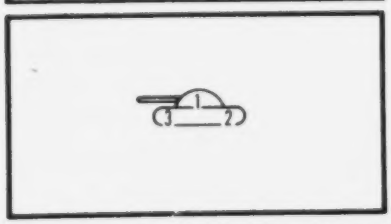
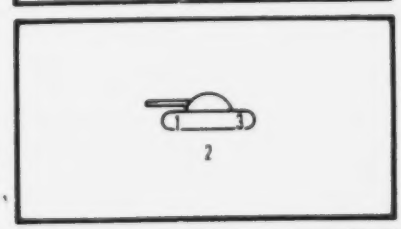
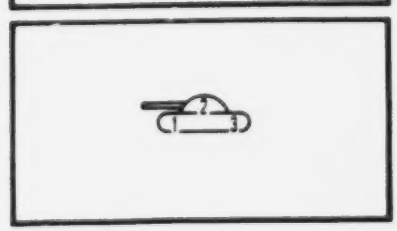
d. Timing sequences will be recorded exactly.

e. Provide the evaluator with the lead card, and the conduct of the test and ensure he understands it.

SAMPLE LEAD CARD

Event	Target Speed MPH	Laser Settings Horiz	Vert	LEAD Announced by C/S should be	Range
1	5	L11.0	12.5	R5	400
2	15	R18.0	20.5	L15	1200
3	10	L14.0	16.0	R10	800
4	25	R26.0	12.5	L20	1600
5	20	L23.0	20.5	R20	1200
6	30	R34.0	16.0	L30	400

BATTERY _____ DATE _____
SECTION _____

EVENT		ROUND	ERROR CAUSED BY GUNNER	ERROR CAUSED BY ASST GUNNER
1		1	X	
		2	X	
		3		X
2		1		
		2		
		3	X	
3		1	X	X
		2	X	X
		3	X	
4		1		
		2		
		3		
5		1		
		2		X
		3		
6		1		
		2		
		3		

NOTE

The third round fired in each event is marked but will not be included in the final score.

SCORE: Hit __ Miss _____

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Figure D-8. Scorer checklist

D-30. **Briefing for Personnel to be Evaluated/ Trained.**

a. You will be rated either satisfactory or unsatisfactory based on your performance. You must score a minimum of 8 GO's to score satisfactory. A hit is a GO. You must fire two rounds, minimum, at each target. Anything less is unsatisfactory. You are further limited in that you must fire the second round within 40 seconds. If it takes 41 seconds or more for you to get off the second round you will be scored a NO-GO for the mission even if you hit the target.

b. You will be required to perform all reloading tasks to include simulation of ramming sequence time. The evaluator will tell you when you can stow the rammer after placing it in the ram position.

c. For every task step that would normally be accomplished, that is skipped, you will be assessed a time penalty by the evaluator.

d. Let me stress that your settings must be accurate and timely in order to pass the test.

e. You may take a third try at the target during each mission for remedial training if you desire.

D-31. **Direct Fire Evaluation Checklist Conduct of the Test.**

a. Require the chief of section to prepare a range card.

(1) Evaluate the card and brief the chief of section.

(a) The card must meet the requirements of FM 6-50.

(b) No score is given for preparation of the card. It is to be used to determine if any remedial training is required.

b. Have the crew take their places in the howitzer.

c. Set the azimuth and elevation controls of the laser in accordance with the lead card and the appropriate event number.

d. Simultaneously

(1) Announce "Number 3 adjust. Target that tank. Fire at will." Target speed____from lead card.

(2) Start the stopwatch.

(3) Signal the target vehicle driver to start.

e. Monitor the actions of the crew. Record any discrepancies for the critique.

NOTE

You must control the loading procedures to ensure all actions are completed and the appropriate delay during ramming is simulated. Assess a 5-second penalty for any loading task omitted.

NOTE

When the second round is announced by the scorer as a hit or miss, stop the stopwatch, and record the time.

	EVENT	TIME	REMARKS (list penalties or comments here)
1			
2			
3			
4			
5			
6			

D-32. **Sample Checklist and Sequence of Events.**

NOTE

This checklist is based on the assumption that the crew has successfully passed its prerange training evaluation.

EVENT____ Record the event number here. Date_____ Btry _____ Sec_____
EVALUATOR: Instructor/Evaluator

a. Set the laser to the setting noted on the lead card for the event taking place.

b. Give the chief of section the range and speed of the target for the event as noted on the lead card.

c. Announce "Battery adjust. Target that tank. Fire at will." and signal the target vehicle operator to start.

d. On the first word of the chief of section's fire order start the stopwatch.

NOTE

Circle all elements or tasks omitted or performed incorrectly. Mark a GO for all correct procedures and a NO-GO for any incorrect procedure. If any doubt exists, mark the procedure correct.

Chief of section's fire order.

1. Warning order (target so and so) ..... GO NO-GO
2. Direction to target (left/right front) ..... GO NO-GO
3. Lead in mils (lead left/right__mils) (within tolerance) ..... GO NO-GO
4. Range (as given by evaluator) ..... GO NO-GO
5. Method of fire (fire at will) ..... GO NO-GO

NOTE

Shell, fuze, and charge to be fired must be announced if they are not designated standard by unit SOP.

GUNNER			ASSISTANT GUNNER			NO. 1 MAN		
1. Cross level pantel	GO	NO-GO	1. Cross level direct fire scope	GO	NO-GO	1. Selects ammo	GO	NO-GO
2. Sets announced lead	GO	NO-GO	2. Lays on target with correct reticle	GO	NO-GO	2. Rams properly	GO	NO-GO
3. Turns bar knob to DIRECT	GO	NO-GO	3. Tracks target	GO	NO-GO	3. Loads charge properly	GO	NO-GO
4. Tracks the target	GO	NO-GO				4. Announces "Close"	GO	NO-GO
						5. Primes	GO	NO-GO
						6. Attaches lanyard	GO	NO-GO
			4. Starts announcing "Set, Set, Set"	GO	NO-GO			
5. Commands "Fire"	GO	NO-GO				7. Fires weapon	GO	NO-GO
6. Continues tracking the target	GO	NO-GO	5. Continues tracking the target	GO	NO-GO	8. Selects ammo	GO	NO-GO
						9. Rams properly	GO	NO-GO
						10. Loads charge	GO	NO-GO
						11. Announces "Close"	GO	NO-GO
						12. Primes	GO	NO-GO
						13. Attaches lanyard	GO	NO-GO
			6. Starts announcing "Set, Set, Set"	GO	NO-GO			
7. Commands "Fire"	GO	NO-GO				14. Fires weapon	GO	NO-GO

EVALUATOR: Stop the stopwatch when the lanyard is actuated.

TIME: 40 seconds or less GO
More than 40 seconds NO-GO

HITS: Second round hit GO
Second round miss NO-GO

OVERALL RATING _____
(Must have all GO's)

_____
(SIGNATURE)

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By Order of the Secretary of the Army:

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Chief of Staff

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PAGE NO	PARAGRAPH	FIGURE NO	TABLE NO	IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
2-6	2-3(4)	2-6		ITEM 4 Incorrectly Labled. Should be labled "Laser On".
2-28	2-5a(3)			Para a(3) doesn't refer to Rechecking the Bubble. Change sentence to read, "Carefully tighten hand knob (2) and recheck the bubble."
A-1	A-2			Incorrect title for FM 6-50 Listed. Should read, "The Field Artillery Cannon Battery".

SAMPLE

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SSG I. M. DeSpiritof 999-1776	S.S.G. I.M. DeSpiritof

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TM 9-6920-357-10-2		Operator's Manual, Trainer, Laser Gunnery and Trainer, Field Artillery.

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